

Anatomy & Physiology

for Speech, Language,
and Hearing

SEVENTH EDITION

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Preface

Anatomy & Physiology for Speech, Language, and Hearing, Seventh Edition, provides a sequential tour of the anatomy and physiology associated with speech, language, and hearing. Those of us studying Speech and Hearing Sciences are in the enviable position of being at the center of one of the most important facets of being human: Communication. In this text, our aspiration is for the content to be both accessible and applicable to your careers in our professions. Even as you read this material, know that your future clients are counting on the knowledge that you are gaining. What you study now becomes the heart of your practice later. We want this material to be relevant to you, the clinician.

This text is designed to serve the upper division undergraduate or graduate student in the fields of speech-language pathology and audiology, and it is our hope that it will serve you as a reference for your professional life as well. We aspire for it to be a learning tool and resource for both the developing and the accomplished clinician. We, the authors of this text, are first and foremost teachers ourselves. We are committed to the students within our professions and to the instructors who have made it their life work to teach them. Every revision of the text has both student and instructor in mind as we try to meet your needs in the rapidly changing professions of Audiology and Speech-Language Pathology.

Learning is not a spectator sport. Our goal is to make the text and its ancillary materials as useful to 21st-century students as possible. This new edition not only provides students with great interactive study tools in the revised ANAQUEST study software but also makes available a wealth of student and instructor resources to facilitate learning. We moved a great deal of the activities online, reflecting the dominant method for using them by students. We want you to be the best clinician and scientist you can be and sincerely hope that these materials move you along the path of your chosen career.

Organization

The text is organized around the five “classic” systems of speech and hearing: the respiratory, phonatory, articulatory/resonatory, nervous, and auditory systems. The respiratory system (involving the lungs) provides the “energy source” for speech, whereas the phonatory system (involving the larynx) provides voicing. The articulatory/resonatory system modifies the acoustic source provided by voicing (or other gestures) to produce the sounds we acknowledge as speech. The articulatory system is responsible for the mastication (chewing) and deglutition (swallowing) function, an increasingly important area within the field of speech-language pathology. The nervous system lets us control musculature, receive information, and make sense of the information. Finally, the auditory mechanism processes speech and nonspeech acoustic signals received by the listener who is trying to make sense of their world. We included information about prenatal and postnatal development of these systems as well as changes that occur through aging.

There are few areas of study where the potential for overwhelming detail is greater than in the disciplines of anatomy and physiology. Our desire with this text and the accompanying software lessons is to provide a stable foundation upon

See the beginning of the textbook for instructions on how to access the *PluralPlus* companion website.

which detail may be learned. In the text, we provide you with an introductory section that sets the stage for the detail to follow, and we bring you back to a more global picture with summaries. We also provide derivations of words to help you remember technical terms.

New to the Seventh Edition

This new edition of *Anatomy & Physiology for Speech, Language, and Hearing* includes many exciting enhancements:

- revised and updated physiology of swallowing includes discussion of postnatal development and aging effects of the swallowing mechanism and function
- brief discussion of the basics of genetics and trait transmission
- overview of prenatal development as it relates to the mechanisms of speech and hearing
- presentation of prenatal and postnatal development for each of the systems of speech and hearing as well as the effects of aging on each system
- content on the effects of pathology on communication, included within each of the physical systems of communication
- addition of clinical cases in neurophysiology and hearing as well as additional study and test questions
- updated lessons and images in ANAQUEST

*J. Anthony Seikel
David G. Drumright
Daniel J. Hudock*

About the Authors

J. Anthony (Tony) Seikel, PhD, is emeritus faculty at Idaho State University, where he taught graduate and undergraduate coursework in neuroanatomy and neuropathology over the course of his career in Communication Sciences and Disorders. He is coauthor of numerous chapters, books, and research publications in the fields of speech-language pathology and audiology. His current research is examining the relationship between orofacial myofunctional disorders and oropharyngeal dysphagia. Dr. Seikel is also coauthor of *Neuroanatomy & Neurophysiology for Speech and Hearing Sciences*, also published by Plural Publishing.

David G. Drumright, BS, grew up in Oklahoma and Kansas, taught electronics at DeVry for several years, then spent 20 years as a technician in acoustics and speech research. He developed many programs and devices for analysis and instruction in acoustics and speech/hearing. He has been semiretired since 2002, working on graphics and programming for courseware. He is also coauthor of *Neuroanatomy & Neurophysiology for Speech and Hearing Sciences*, published by Plural Publishing.

Daniel J. Hudock, PhD, CCC-SLP, is an associate professor of Communication Sciences and Disorders at Idaho State University who has taught courses on anatomy and physiology of the speech and hearing mechanisms and speech and hearing science for over a decade. He has published more than 30 articles and has given over 100 presentations. In his TEDx Talk (<https://bit.ly/2oAYeKC>) titled “Please Let Me Finish My Sentence,” he presents his experience living with a stutter. Dr. Hudock is also the founding director of the Northwest Center for Fluency Disorders that offers an intensive interprofessional stuttering clinic with speech-language pathologists collaborating with counselors and clinical psychologists through an Acceptance and Commitment Therapy (ACT) informed framework in the treatment of adolescent and adult stuttering, which is his main area of research.

Introduction to the Learner

We continue to be impressed with the complexity and beauty of the systems of human communication. Humans use an extremely complex system for communication, requiring extraordinary coordination and control of an intensely interconnected sensorimotor system. It is our heartfelt desire that the study of the physical system will lead you to an appreciation of the importance of your future work as a speech-language pathologist or audiologist.

We also know that the intensity of your study will work to the benefit of your future clients and that the knowledge you gain through your effort will be applied throughout your career. We appreciate the fact that the study of anatomy is challenging, but we also recognize that the effort you put forth now will provide you with the background for work with the medical community.

A deep understanding of the structure and function of the human body is critical to the individual who is charged with the diagnosis and treatment of speech, language, and hearing disorders. As beginning clinicians, you are already aware of the awesome responsibility you bear in clinical management. It is our firm belief that knowledge of the human body and how it works will provide you with the background you need to make informed and wise decisions. We welcome you on your journey into the world of anatomy.

Using This Textbook and Online Resources

Textbook

The text offers the following features to enhance your learning and comprehension:

- Learning Outcomes** provide a guide on how to navigate the depth and breadth of the chapter content.
- Margin Notes** identify important terminology, root words, and definitions that are highlighted in color throughout each chapter. Other important terms are boldfaced in text to indicate that the definition can be found in the Glossary at the end of the book. Use these terms to study and prepare for tests and quizzes. Additionally, callouts in the margin indicate corresponding ANAQUEST lessons and video labs.
- Clinical Notes** relate a topic directly to clinical experience to emphasize the importance of anatomy in your clinical practice. Gain insight into your chosen profession by using the topics discussed for research papers, to facilitate in-class discussion, and to complete homework assignments.
- Illustrations and Graphs** provide visual examples of the anatomy, processes, and body systems discussed. Refer to the figures as you read the text to enhance your understanding of the specific idea or anatomical component being discussed. When reviewing for quizzes and tests, refer back to the figures for an important visual recap of the topics discussed.
- Photographs** provide a real-life look at the body parts and functions you are studying. Use these images as reference for accuracy in describing body systems, parts, and processes. Allow yourself to be amazed by the intricacies of human anatomy.
- Tables** highlight the various components, functions, structures, and pathologies of anatomical concepts related to what you might encounter in actual practice. Use these tables for quick reference to study and learn to relate your new anatomical knowledge to clinical experience. **Muscle Tables** describe the origin, course, insertion, innervation, and function of key muscles and muscle groups. Use these tables to stay organized and keep track of the numerous muscles studied in the chapters.

Anatomy of Phonation 4

LEARNER OUTCOMES

1. Expressively define, and receptively identify on graphic image the pharynx, nasopharynx, and larynx, including the functional units of the pharynx, epiglottis, aryepiglottic folds, vocal ligament, cornu hyaline, and pre-epiglottic space.
2. Discuss the relationship among the cartilages and bones of the larynx, and their functions.
3. Describe the relationship among the cartilages and bones of the larynx, and their functions.
4. Identify each of the laryngeal cartilages and ligaments of those cartilages, as well as the hyoid bone and its landmarks from graphic image.
5. Receptively identify the level and directional specialization of the larynx of the vocal fold.
6. Identify the cartilage, landmarks, and structures of the larynx through description or visual image.
7. Describe the location of structures and spaces of the larynx.
8. Describe the movements and articulation of the cartilages, including the functional units of the larynx.
9. Define the intrinsic laryngeal musculature origin, insertion, course, function, and innervation, as well as identify on a graphic image.
10. Receptively identify from an image and description the functions of the aryepiglottic and thyroepiglottic muscles.
11. Identify the origin, insertion, course, function, and innervation of the inferior and superior laryngeal muscles, and receptively identify the muscles on graphic image.

There is a great deal of detail in the anatomy of the pharynx, larynx, and trachea, and you should follow the path of your instructor when reading this content.

ANAQUEST LESSON

Lesson 1: all of the parts

Student communication use both vocal and non-vocal sounds, and this chapter is concerned with the critical distinction. As you remember, speech sounds are produced within the oral cavity, and the vocal folds are the source of energy for speech. Remember from Chapter 3 that we entered as respiratory there would be no voice.

The vocal folds are made up of five layers of tissue, with the deepest layer being muscle. The space between the vocal folds is termed the **glottis** for times the airway passes between the vocal folds, they may be made to vibrate, thus producing a sound. If you already produce it, and if, you should for the most part vibrating and stop, because of a **glottis**.

Odontoid Malformations

Odontoid malformations are those in which the odontoid process of C2 fails to develop, but can be seen in the C2 vertebra. In some cases, the odontoid process of C2 is fused to the body of the vertebra, resulting in a bony bridge between the odontoid process and the body of the vertebra. This is a congenital malformation, and the odontoid process is not normally present. The odontoid process is a bony projection that projects from the anterior surface of the dens of the axis (C2) and articulates with the posterior surface of the dens of the axis. The odontoid process is a bony projection that projects from the anterior surface of the dens of the axis. The odontoid process is a bony projection that projects from the anterior surface of the dens of the axis.

pedicle 1, pedicle 1

The superior surface is marked by a superior articular facet, which may vary in size. The inferior surface contains an inferior articular facet. In the anterior view, the inferior surface contains an inferior articular facet. In the anterior view, the inferior surface contains an inferior articular facet. In the anterior view, the inferior surface contains an inferior articular facet.

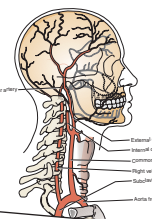


Figure 3-18. Course of vertebral artery through the transverse foramina of the cervical vertebrae.

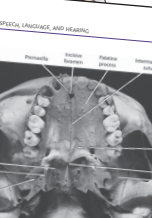


Figure 3-19. Course of vertebral artery through the transverse foramina of the cervical vertebrae.

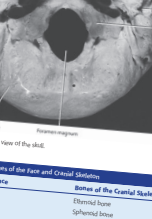


Table 3-1. Bones of the Face and Cranial Skeleton

Bones of the Face	Bones of the Cranial Skeleton
Mandible	Frontal bone
Maxilla	Sphenoid bone
Nasal bone	Parietal bone
Palatine bone and nasal concha	Temporal bone
Nasal	Occipital bone
Zygomatic bone	Occipital condyle
Lacrimal bone	Occipital condyle
Mental bone	Occipital condyle



- **“To Summarize” Sections** provide a succinct listing of the major topics covered in a chapter or chapter section. These summaries provide a helpful recap of the general areas where you should focus your time while reviewing for examinations.
- **Chapter Summaries** provide precise reviews of content. The summary is offset from the running text to make it easily identifiable for quick review.
- A **Bibliography** with a comprehensive list of references at the end of each chapter offers great sources to start your research for a paper or class project.
- A **Glossary** lists all key terms found throughout the text.

Online Resources

The text is supported by a suite of supplementary resources on a **PluralPlus companion website**. The site is divided into two areas: one housing materials for the instructor and the other just for students.

ANAQUEST

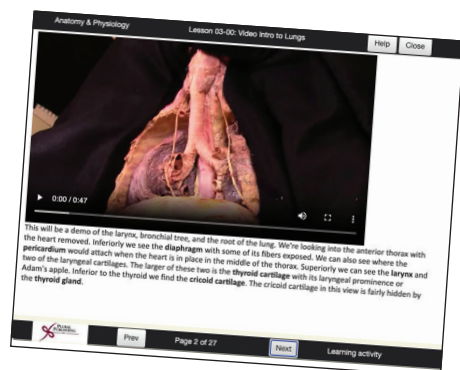
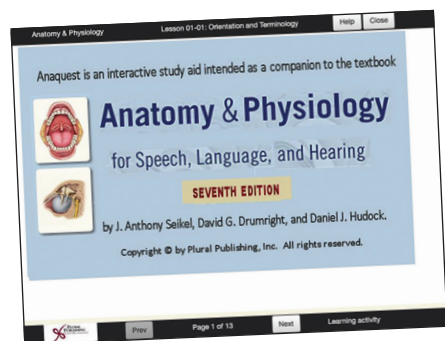
The innovative software program, **ANAQUEST**, is available in two different versions: one for instructors to import into their Learning Management Systems (LMS) for exams, and another web-based version for student study. ANAQUEST features interactive **lessons, images, animations, and videos**.

For the Instructor

The instructor area of the PluralPlus companion website contains a variety of tools to help instructors successfully prepare lectures and teach within this subject area. This comprehensive package provides something for all instructors, from those teaching anatomy and physiology for the first time to seasoned instructors who want something new. The resources include the following:

- *PowerPoint slides* for each chapter
- a *test bank* with over 1,000 questions and answers
- *class activities* and *labs*
- a sample *syllabus*
- *videos*
- a version of *ANAQUEST* importable to the leading LMSs
- access to the student section of the companion website

See the inside front cover of the book on how to gain instructor access to the website.



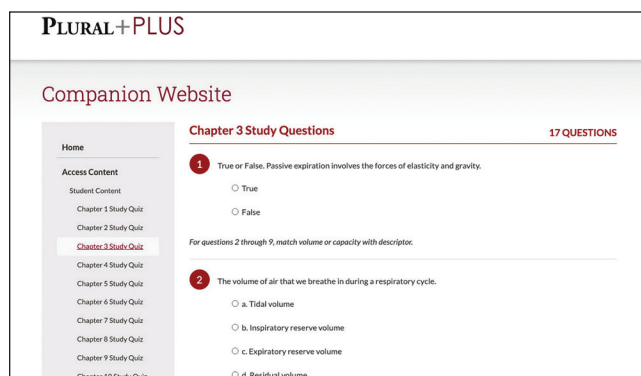
For the Student

To further help students master complex material, the student area of the Plural-Plus companion website includes the following:

- interactive *study quizzes* for each chapter
- *videos*
- downloadable *appendices*
- a student web-version of the *ANAQUEST* study software

The ANAQUEST software is keyed to the text, reinforcing identification of the structures presented during lecture and, more importantly, illustrating the function of those structures. The lessons and videos are self-paced, with frequent quizzes. Spending two or three half-hour sessions per week will be a great refresher while preparing for exams.

See the inside front cover of the book for the website URL and your access code.



The screenshot displays the Plural+Plus Companion Website interface. At the top left, the logo "PLURAL+PLUS" is visible. Below it, the text "Companion Website" is centered. On the left side, there is a navigation menu with options: Home, Access Content, Student Content, Chapter 1 Study Quiz, Chapter 2 Study Quiz, Chapter 3 Study Quiz (highlighted in red), Chapter 4 Study Quiz, Chapter 5 Study Quiz, Chapter 6 Study Quiz, Chapter 7 Study Quiz, Chapter 8 Study Quiz, Chapter 9 Study Quiz, and Chapter 10 Study Quiz. The main content area is titled "Chapter 3 Study Questions" and indicates "17 QUESTIONS". The first question is a True or False question: "Passive expiration involves the forces of elasticity and gravity." with radio buttons for True and False. The second question is a matching question: "The volume of air that we breathe in during a respiratory cycle." with radio buttons for four options: a. Tidal volume, b. Inspiratory reserve volume, c. Expiratory reserve volume, and d. Residual volume.

Basic Elements of Anatomy

1

LEARNING OBJECTIVES

The learner will be able to:

1. Define and demonstrate an understanding of the terminology of anatomy and physiology as it relates to the body, its position in space, and movement of its parts.
2. Demonstrate receptive knowledge of the subspecializations of anatomy and physiology.
3. Identify the four basic tissue types, and define their general function in the body.
4. Receptively differentiate the derivatives, and functions of those derivatives, of epithelial tissue, connective tissue, muscular tissue, and nervous tissue.
5. Receptively identify joint types of the skeleton.
6. Discuss muscle function as it relates to exertion of force on the skeletal structures.
7. Differentiate fascia, ligaments, and tendons.
8. Define the systems of the body and how they relate to the systems of communication.
9. Describe the basic function of the central and peripheral nervous systems.
10. Relate the name, number, and general function of each cranial nerve, the name and general function of lobes of the cerebellum, lobes of the cerebral cortex, and structures of the brainstem.
11. Relate the difference among autosomal dominant, autosomal recessive, and sex-linked inheritance, and between genotype and phenotype.
12. Define the times that indicate the embryonic and fetal stages of development.
13. Receptively differentiate general structures that arise from endoderm, ectoderm, and mesoderm in development.
14. Receptively differentiate the structures of the face, head, and neck that arise from each pharyngeal arch.

There is a great deal of detail in this introductory information, and you should follow the guidance of your instructor when studying this content.

You are entering into a study of the human body that has a long and rich tradition. We are fortunate to have myriad instruments and techniques at our avail for this study, but it has not always been so. You will likely struggle with arcane terminology that seems confusing and strange, and yet if you look closely, you will see what the early anatomists first saw. The amygdala of the brain is a small almond-shaped structure, and *amygdala* means “almond.” *Lentiform* literally means “lens-shaped,” and the lentiform nucleus is just that. The fact that the terminology remains in our lexicon indicates the accuracy with which our academic ancestors studied their field, despite extraordinarily limited resources.

This chapter provides you with some basic elements to prepare you for your study of the anatomy and physiology of speech, language, and hearing. We provide a broad picture of the field of anatomy and then introduce you to the basic tissues that make up the human body. Tissues combine to form structures, and those structures combine to form systems. This chapter sets the stage for your understanding of the new and foreign anatomical terminologies.

ANAQUEST LESSON 

anatomy dissection: Gr, anatome

dissection: L., dissecare, the process of cutting up

physiology: Gr., physis, nature; logos, study; function of an organism

applied anatomy or **clinical anatomy:** application of anatomical study for the diagnosis and treatment of disease, particularly as it relates to surgical procedures

descriptive anatomy or **systemic anatomy:** anatomical specialty involving the description of individual parts of the body without reference to disease conditions

gross anatomy: study of the body and its parts as visible without the aid of microscopy

microscopic anatomy: study of the structure of the body by means of microscopy

surface anatomy or **superficial anatomy:** study of the body and its surface markings as related to underlying structures

developmental anatomy: study of anatomy with reference to growth and development from conception to adulthood

pathological anatomy: study of parts of the body with respect to the pathological entity

comparative anatomy: study of homologous structures of different animals

electrophysiological techniques: those techniques that measure the electrical activity of single cells or groups of cells, including muscle and nervous system tissues

evoked auditory potential: electrical activity of the brain that is directly associated with hearing an auditory stimulus, an example of this is an auditory brainstem response

Anatomy and Physiology

Anatomy refers to the study of the *structure* of an organism. **Physiology** is the study of the *function* of the living organism and its parts, as well as the chemical processes involved. **Applied anatomy** (also known as **clinical anatomy**) involves the application of anatomical study for the diagnosis and treatment of disease and surgical procedures. **Descriptive anatomy** (also known as **systemic anatomy**) is a description of individual parts of the body without reference to disease conditions, viewing the body as a composite of systems that function together. **Gross anatomy** studies structures that are visible without a microscope, while **microscopic anatomy** examines structures not visible to the unaided eye. **Surface anatomy** (also known as **superficial anatomy**) studies the form and structure of the surface of the body, especially with reference to the organs beneath the surface (Gilroy et al., 2012; Gray & Standring, 2008; Rohen et al., 2011; Tank & Grant, 2012). **Developmental anatomy** deals with the development of the organism from conception (Moore et al., 2020).

When your study examines disease conditions or structural abnormalities, you have entered the domain of **pathological anatomy**. When we make comparisons across species boundaries, we are engaged in **comparative anatomy**. Examination of physiological processes may entail the use of a range of methods, from simply measuring forces exerted by muscles to highly refined **electrophysiological techniques** that measure electrical activity of single cells or groups of cells, including muscle and nervous system tissues. For example, audiologists are particularly interested in procedures that measure the electrical activity of the brain caused by auditory stimuli (**evoked auditory potentials**). We rely heavily on descriptive anatomy to guide our understanding of the physical mechanisms of speech and to aid our discussion of its physiology (e.g., Duffy, 2019). Study of pathological anatomy occurs naturally as you enter your clinical process because many of the

Teratogen

A **teratogen** or teratogenic agent is anything causing teratogenesis, the development of a severely malformed fetus. For an agent to be teratogenic, its effect must occur during prenatal development. Because the development of the fetus involves the proliferation and differentiation of tissues, the timing of the teratogen is particularly critical. The heart undergoes its most critical period of development from the third week to the eighth, while the critical period for the palate begins around the fifth week and ends around the 12th week. The critical period for neural development stretches from the third week until birth. These critical periods for development mark the points at which the developing human is most susceptible to insult. An agent destined to have an effect on the development of an organ or system will have its greatest impact during that critical period.

Many teratogens have been identified, including organic mercury (which causes cerebral palsy, cognitive impairment, blindness, cerebral atrophy, and seizures), heroin and morphine (causing neonatal convulsions, tremors, and death), alcohol (fetal alcohol syndrome, cognitive impairment, microcephaly, joint anomalies, and maxillary anomalies), and tobacco (growth restriction), to name just a few.

acquired conditions speech-language pathologists or audiologists work with arise from pathological changes in structure.

We need to call on knowledge from related fields to support your study of anatomy and physiology. **Cytology** is the discipline that examines structure and function of cells; **histology** is the microscopic study of cells and tissues. **Osteology** studies the structure and function of bones, while **myology** examines muscle form and function. **Arthrology** studies the joints uniting bones, and **angiology** is the study of blood vessels and the lymphatic system. **Neurology** is the study of diseases of the nervous system.

✓ To summarize:

- **Anatomy** is the study of the structure of an organism; **physiology** is the study of function.
- **Descriptive anatomy** relates the individual parts of the body to functional systems.
- **Pathological anatomy** refers to changes in structure as they relate to disease.
- **Gross** and **microscopic anatomy** refer to levels of visibility of structures under study.
- **Developmental anatomy** examines growth and development of an organism.
- **Cytology** and **histology** study cells and tissues, respectively. **Myology** examines muscle form and function.
- **Arthrology** refers to the study of the joint system for bones, while **osteology** is the study of form and function of bones.
- **Neurology** refers to the study of diseases of the nervous system.

Terminology of Anatomy

Terminology allows us to communicate relevant information concerning the location and orientation of various body parts and organs, so clarity of terminology is of the utmost importance in the study of anatomy. Terminology also links us to the historic roots of this field of study. To the budding scholar of Latin or Greek, learning the terms of anatomy is an exciting reminder of our linguistic history. To the rest of us, the terms we are about to discuss may be less easily digested but are nonetheless important.

As you prepare for your study of anatomy, please realize that this body of knowledge is extremely hierarchical. *What you learn today will be the basis for what you learn tomorrow.* Not only are the terms the bedrock for understanding anatomical structures but mastery of their usage will let you gain the maximum benefit from new material presented.

Terms of Orientation

In the **anatomical position**, the body is erect, and the palms, arms, and hands face forward, as shown in Figure 1–1A. Terms of direction assume this position. The body and brain (and many other structures) are seen to have axes (plural of axis), or midlines from which other structures arise. The **axial skeleton** is the head and trunk, with the spinal column being the axis, while the **appendicular**

cytology: Gr., kytos, cell; logos, study

histology: Gr., histos, web, tissue; logos, study

osteology: Gr., osteon, bone; logos, study

myology: Gr., mys, muscle; logos, study

arthrology: Gr., arthron, joint; logos, study

angiology: Gr., angio, blood vessels; logos, study

neurology: Gr., neuron, sinew, nerve; logos, study

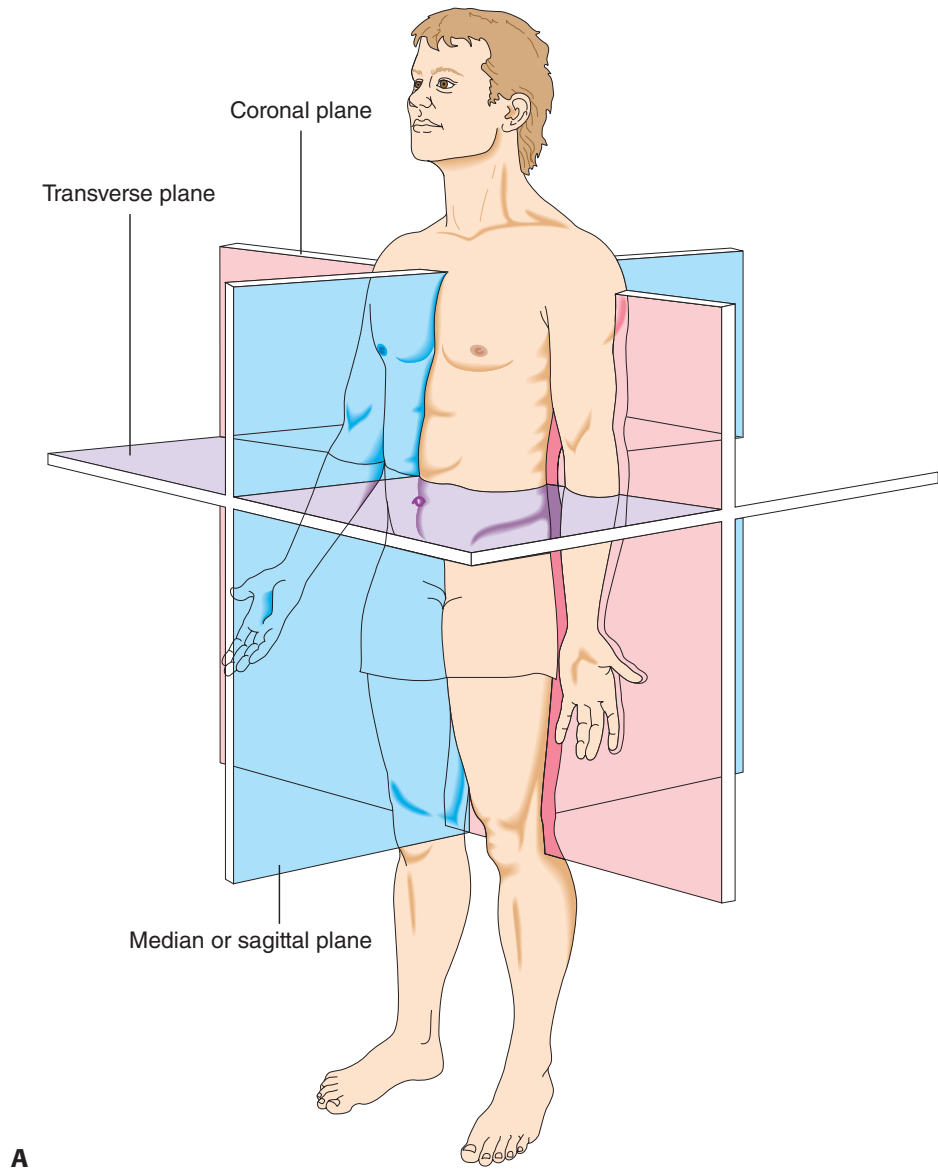
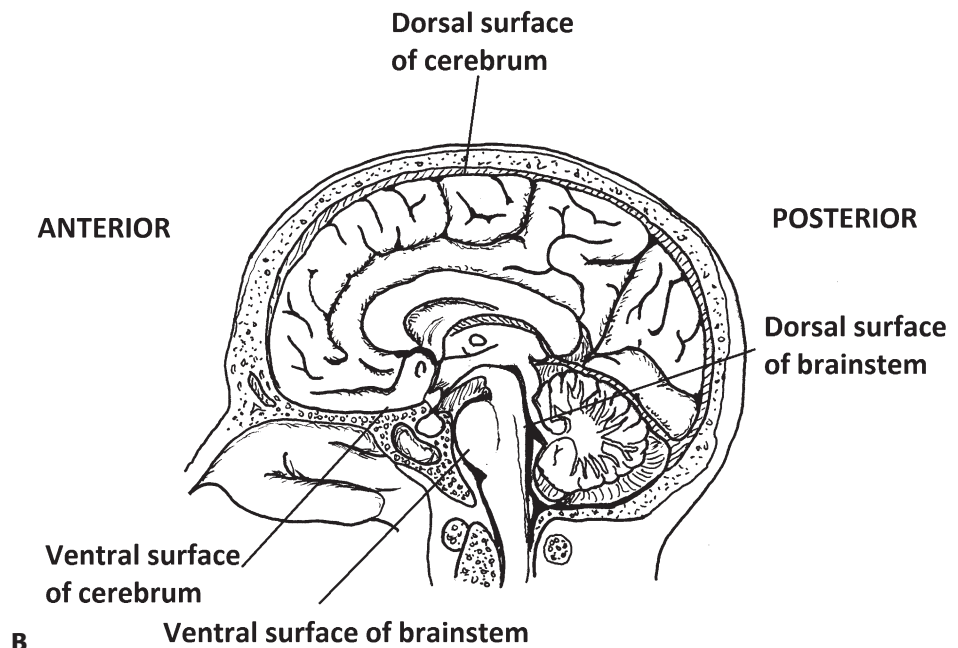


Figure 1-1. A. Terms and planes of orientation. *Source:* From Seikel/Drumright/King. *Anatomy & Physiology for Speech, Language, and Hearing*, 5th ed. © Cengage, Inc. Reproduced by permission. B. The neuraxis of the brain. *Source:* From *Neuroanatomy and Neurophysiology for Speech and Hearing Sciences* (pp. 1–385) by Seikel, J. A., Konstantopoulos, K., & Drumright, D. G. Copyright © 2020 Plural Publishing, Inc. All rights reserved. Used with permission.



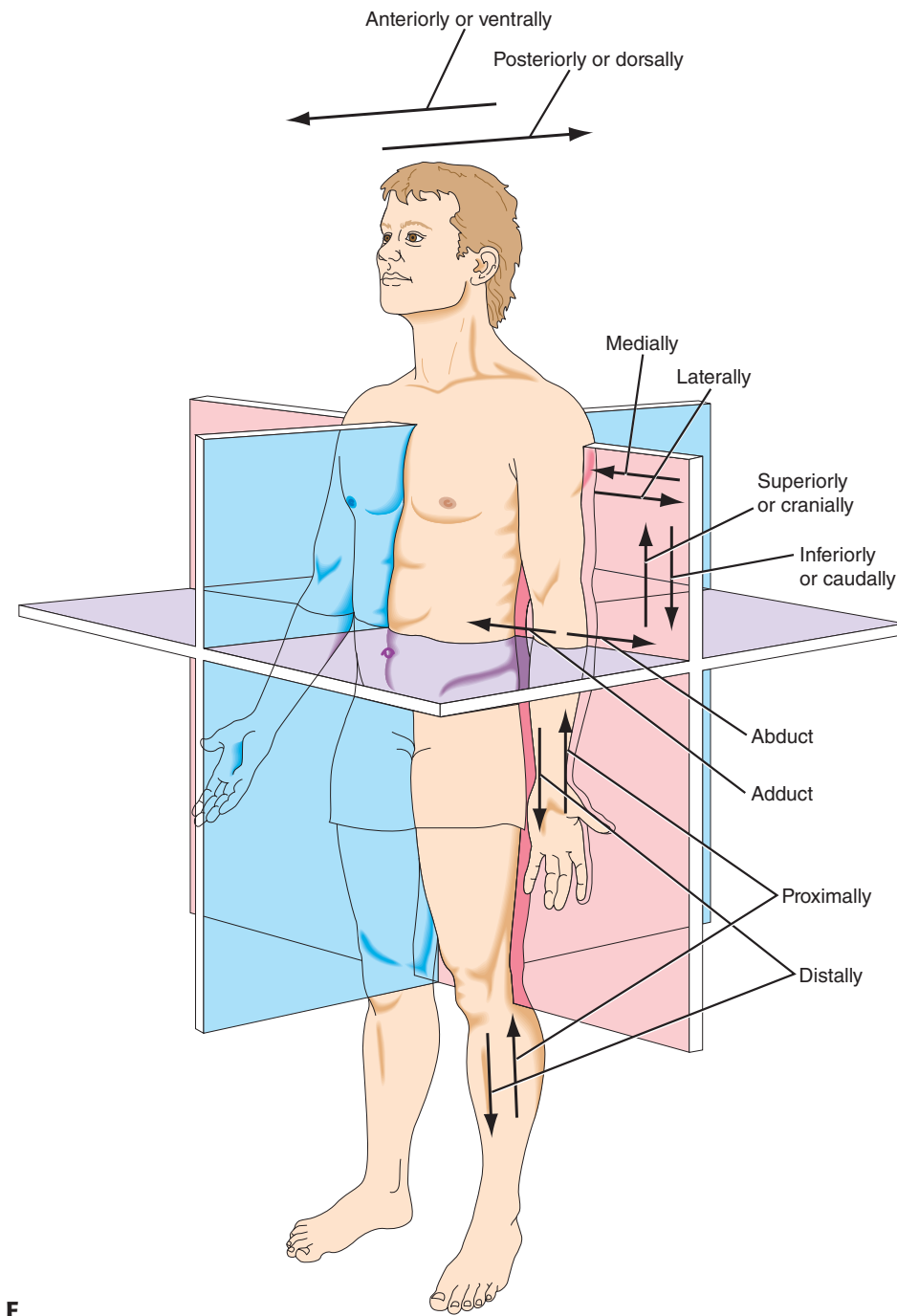
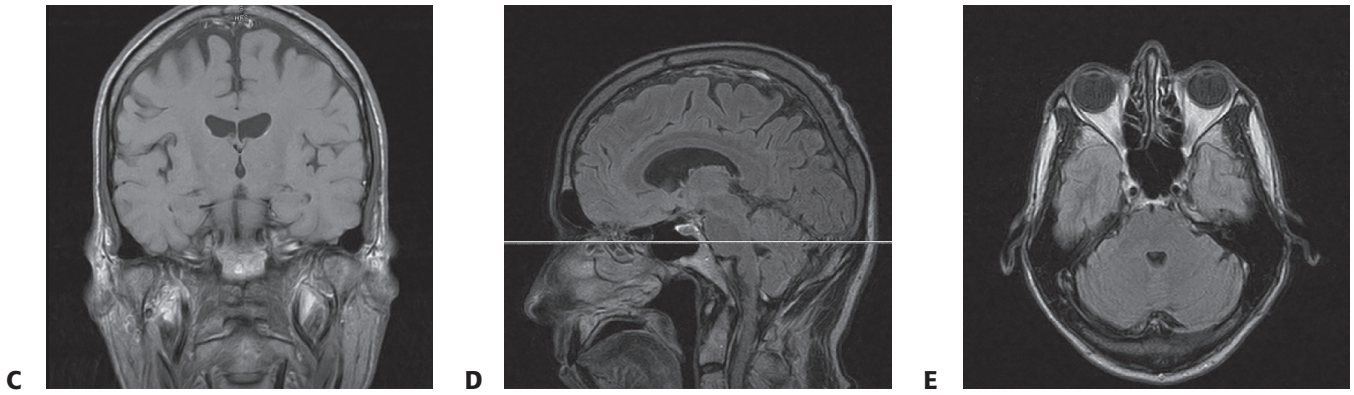


Figure 1-1. continued
C. Coronal section through brain and skull using magnetic resonance imaging (MRI). **D.** Sagittal or median section through brain and skull using MRI. **E.** Transverse section through brain and skull using MRI. **F.** Terms of movement. *Source:* From Seikel/Drumright/King. *Anatomy & Physiology for Speech, Language, and Hearing*, 5th ed. © Cengage, Inc. Reproduced by permission. *continues*

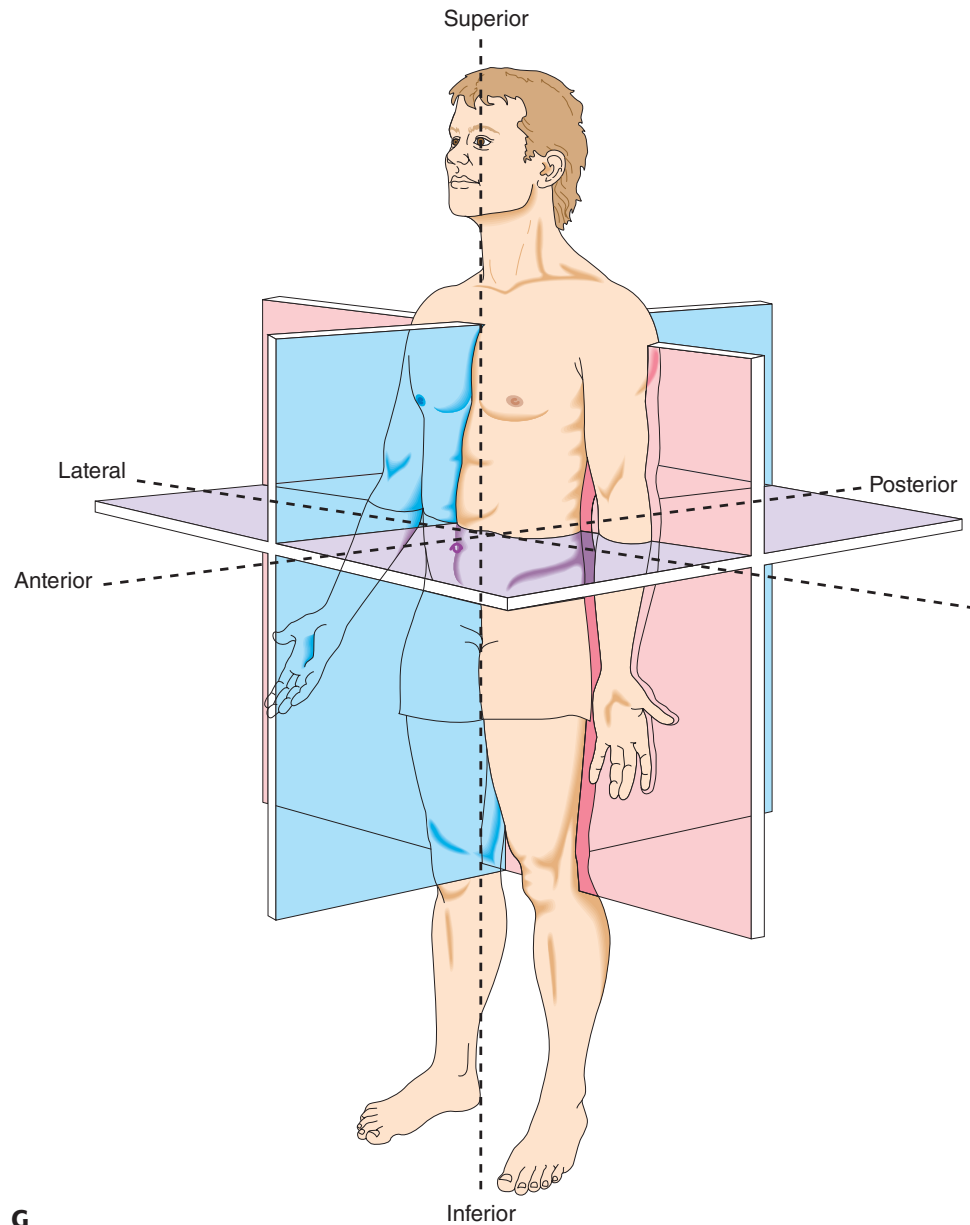


Figure 1-1. *continued*

G. Terms of spatial orientation.
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 Speech, Language, and Hearing*,
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G

skeleton includes the upper and lower limbs. The **neuraxis**, or the axis of the brain, is slightly less straightforward due to morphological changes of the brain during development. The embryonic nervous system is essentially tubular, but as the cerebral cortex develops, a flexure occurs and the telencephalon (the region that will become the cerebrum) folds forward. As a result, the neuraxis assumes a T-formation (Moore et al., 2020). The spinal cord and brainstem have dorsal (back) and ventral (front) surfaces corresponding to those of the surface of the body. Because the cerebrum folds forward, the dorsal surface is also the superior surface, and the ventral surface is the inferior surface. Most anatomists avoid this confusing state by referring to the ventral and dorsal surfaces of the embryonic brain as inferior and superior surfaces, respectively (Figure 1-1B).

Some terms are related to the physical orientation of the body (such as *vertical* or *horizontal*). Other terms (such as *frontal*, *coronal*, and *longitudinal*)

Those of you who play cards may remember “Ante up,” meaning, “Put your money up front!” You may remember the term antebellum, meaning “before the war.”

refer to planes or axes of the body and are therefore insensitive to the position of the body.

You may think of the following planes as referring to sections of a standing body, but they are actually defined relative to imaginary axes of the body. If you were to divide the body into front and back sections, you would have produced a **frontal section** or **frontal view**. If you cut the body into left and right halves, this would be along the **median** plane, and it would produce **midsagittal sections**. A **sagittal section** is any cut that is parallel to the median plane and divides the body into left and right portions: The cut is in the sagittal plane. The **transverse section** divides the body into upper and lower portions. (This plane is often referred to by radiologists as *transaxial* or *axial*, and the radiological orientation always assumes you are looking from the feet toward the head.) Figure 1–1A illustrates these sections. Armed with these basic planes of reference, you could rotate a structure in space and still discuss the orientation of its parts.

The term **anterior** refers to the front surface of a body. **Ventral** and anterior are synonymous for the standing human but have different meanings for a quadruped. The ventral aspect of a standing dog includes its abdominal wall, which is directed toward the ground. The anterior of the same dog would be the portion including the face.

The opposite of anterior is **posterior**, meaning toward the back. For those of us who walk on two feet, “posterior” and “**dorsal**” both refer to the same region of the body. The posterior aspect of a four-footed animal differs from that of humans. Thus, you may refer to a muscle running toward the anterior surface, or a structure having a specific landmark in the posterior aspect. These terms are body specific: Regardless of the position of the body, anterior is toward the front of that body. The term **rostral** is often used to mean toward the head. If the term is used to refer to structures within the cranium, rostral refers to a structure anterior to another.

When discussing the course of a muscle, we often need to clarify its orientation with reference to the surface or level within the body. A structure may be referred to as **peripheral** (away from the center) to another. A structure is **superficial** if it is confined to the surface.

When we say one organ is “**deep** to” another organ, we mean it is closer to the axis of the body. A structure may also be referred to as being **external** or **internal**, but these terms are generally reserved for cavities within the body. You may refer to an aspect of an appendicular structure (such as arms and legs) as being **distal** (away from the midline) or **proximal** (toward the root or attachment point of the structure).

A few terms refer to the actual present position of the body rather than a description based on the anatomical position. **Superior** (above, farther from the ground) and **inferior** (below, closer to the ground) are used in situations in which gravity is important. Superior can also indicate relative location. Structures that are near the head are referred to as superior or cranial, while those near the feet are referred to as inferior or caudal (the term *caudal* is more often used in this context when referring to an embryo). The terms **prone** (on the belly) and **supine** (on the back) are also commonly used in describing the present actual position.

Often, we need to describe the orientation of a structure relative to another structure. Some useful terms are **lateral** (related to the side) and **medial** (toward the median plane). If a point is closer to the median plane (the one that divides the body into left and right halves), it is medial to a point that is farther from that plane, which is lateral. So you would say, for instance, that the tongue is medial to the molars in the mandible because it is closer to the midline or median plane.

frontal section or **frontal view**: divides body into front and back halves

midsagittal section: an anatomical section that divides the body into left and right halves in the median plane

sagittal section: divides the body or body part into right and left sections

anterior: front

ventral: pertaining to the belly or anterior surface

posterior: toward the rear

dorsal: pertaining to the back of the body

rostral: L., rostralis, beak-like

The term quadruped refers to four-footed animals. The term biped refers to two-footed animals.

peripheral: relative to the periphery or away from superficial; on or near the surface

superficial: on or near the surface

deep: farther from the surface

external: L., externus, outside

internal: within the body

distal: away from the midline

proximal: L., proximus, next to

prone: body in horizontal position with face down

supine: body in horizontal position with face up

lateral: toward the side