

FUNDAMENTALS of  
**ANATOMY** and **PHYSIOLOGY**  
of **Speech, Language, and Hearing**

Glen M. Tellis, PhD, CCC-SLP, F-ASHA  
M. Hunter Manasco, PhD, CCC-SLP





9177 Aero Drive, Suite B  
San Diego, CA 92123

email: [information@pluralpublishing.com](mailto:information@pluralpublishing.com)  
website: <https://www.pluralpublishing.com>

Copyright © 2025 by Plural Publishing, Inc.

Typeset in 11.5/14 Adobe Garamond by Flanagan's Publishing Services, Inc.  
Printed in China by Regent Publishing Services Ltd.

All rights, including that of translation, reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, recording, or otherwise, including photocopying, recording, taping, web distribution, or information storage and retrieval systems without the prior written consent of the publisher.

For permission to use material from this text, contact us by  
Telephone: (866) 758-7251  
Fax: (888) 758-7255  
email: [permissions@pluralpublishing.com](mailto:permissions@pluralpublishing.com)

*Every attempt has been made to contact the copyright holders for material originally printed in another source. If any have been inadvertently overlooked, the publisher will gladly make the necessary arrangements at the first opportunity.*

**Library of Congress Cataloging-in-Publication Data:**

Names: Tellis, Glen M., author. | Manasco, Hunter, author.

Title: Fundamentals of anatomy and physiology of speech, language, and hearing / Glen M. Tellis, M. Hunter Manasco.

Description: San Diego, CA : Plural Publishing, Inc., [2025] | Includes bibliographical references and index.

Identifiers: LCCN 2023022249 (print) | LCCN 2023022250 (ebook) | ISBN 9781635507201 (hardcover) | ISBN 9781635504682 (ebook)

Subjects: MESH: Speech--physiology | Language | Hearing--physiology | Nervous System--anatomy & histology | Respiratory System--anatomy & histology | Respiratory Physiological Phenomena

Classification: LCC RC424.7 (print) | LCC RC424.7 (ebook) | NLM WV 501 | DDC 616.85/5--dc23/eng/20230612

LC record available at <https://lcn.loc.gov/2023022249>

LC ebook record available at <https://lcn.loc.gov/2023022250>

**NOTICE TO THE USER**

Care has been taken to confirm the accuracy of the indications, procedures, drug dosages, and diagnosis and remediation protocols presented in this book and to ensure that they conform to the practices of the general medical and health services communities. However, the authors, editors, and publisher are not responsible for errors or omissions or for any consequences from application of the information in this book and make no warranty, expressed or implied, with respect to the currency, completeness, or accuracy of the contents of the publication. The diagnostic and remediation protocols and the medications described do not necessarily have specific approval by the Food and Drug administration for use in the disorders and/or diseases and dosages for which they are recommended. Application of this information in a particular situation remains the professional responsibility of the practitioner. Because standards of practice and usage change, it is the responsibility of the practitioner to keep abreast of revised recommendations, dosages, and procedures.

# Brief Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>2</b>	<b>Anatomy of Respiration</b>	<b>47</b>
<b>3</b>	<b>Physiology of Respiration</b>	<b>107</b>
<b>4</b>	<b>Anatomy of Phonation</b>	<b>133</b>
<b>5</b>	<b>Physiology of Phonation</b>	<b>167</b>
<b>6</b>	<b>Anatomy of Articulation, Swallowing, and Resonance</b>	<b>193</b>
<b>7</b>	<b>Physiology of Articulation and Resonance</b>	<b>265</b>
<b>8</b>	<b>Physiology of Swallowing</b>	<b>287</b>
<b>9</b>	<b>Anatomy of Hearing</b>	<b>315</b>
<b>10</b>	<b>Physiology of Hearing and Balance</b>	<b>337</b>
<b>11</b>	<b>Neuroanatomy and Neurophysiology: Part 1</b>	<b>369</b>
<b>12</b>	<b>Neuroanatomy and Neurophysiology: Part 2</b>	<b>393</b>

# Contents

<i>Preface</i>	<i>xiii</i>
<i>Acknowledgments</i>	<i>xv</i>
<b>1 Introduction</b>	<b>1</b>
Key Terms	1
Biology	1
Anatomy	2
Physiology	4
Anatomical Nomenclature	4
Anatomical Orientation	5
Anatomical Terms	5
Body Systems That Support Speech, Language, and Hearing	9
Cell	9
Tissues	10
Joints or Articulations	24
Organs	27
Systems	27
Cranial Nerves	32
Olfactory	33
Optic	34
Oculomotor	36
Trochlear	36
Trigeminal	36
Abducens	37
Facial	37
Vestibulocochlear	38
Glossopharyngeal	39
Vagus	40
Accessory	42
Hypoglossal	42
Chapter Summary	43
References	45
<b>2 Anatomy of Respiration</b>	<b>47</b>
Introduction to Respiration	47
The Skeletal Framework for Respiration	49
The Bony Thorax	49
The Visceral Thorax	64

Respiratory Passages	64
Lungs	69
Respiratory Tissue and Gas Exchange	72
Muscles of Respiration	74
Patterns of Muscular Use in Respiration	75
Categorization of Muscles of Respiration	75
Primary Muscle of Inspiration	76
Accessory Muscles of Inspiration	78
Muscles of Expiration	92
Chapter Summary	102
Reference	105
<b>3 Physiology of Respiration</b>	<b>107</b>
Introduction to Physiology of Respiration	107
Forces of Respiration	111
Active Force of Respiration	111
Passive Forces of Respiration	111
Pressures Involved in Respiration	112
Physics of Respiration/Breathing	113
Understanding the Mechanical Cycle of Respiration	116
Quiet Respiration: Quiet Inspiration/Passive Expiration	116
Forced Respiration: Forced Inspiration/Forced Expiration	117
Lung Volumes and Capacities	117
Changes in Respiration With Advanced Age	120
Measurement of Respiration and Instrumentation	120
Measuring Rate	121
Measuring Pressure	121
Measuring Lung Volumes and Respiratory Capacities	122
Process of Gas Exchange	125
Chapter Summary	129
References	132
<b>4 Anatomy of Phonation</b>	<b>133</b>
Introduction	133
Larynx	138
Cartilages of the Larynx	138
Membranes and Ligaments	146
Muscles of the Larynx	149
Chapter Summary	163
References	164
<b>5 Physiology of Phonation</b>	<b>167</b>
Nonspeech (Biological) Functions	167
Breathing	168
Abdominal and Thoracic Fixation	168
Protection During the Swallow Reflex	168
Throat Clearing and Coughing	168

Phonation	168
Coordinative Structures of Voice	169
Theories of Phonation	170
Myoelastic-Aerodynamic Theory	170
Body-Cover Theory	172
Nonlinear Source-Filter Coupling Theory	173
Parameters of Voice	174
Elasticity, Stiffness, and Inertia	174
Acoustic Parameters	174
Amplitude and Intensity	179
Aerodynamic Parameters	180
Variations in Vocal Fold Closure Patterns, Mucosal Wave, and Periodicity of Vibration	182
Vocal Fold Closure	182
Movement of the Mucosal Wave	184
Regularity and Periodicity of Vibration	185
Vocal Register	186
Sustained Phonation and Attack	188
Linguistic Aspects of Phonation	188
Chapter Summary	189
References	191

## **6 Anatomy of Articulation, Swallowing, and Resonance 193**

Introduction	194
Bones of the Face	194
Mandible	194
Maxillae	196
Anatomy of the Hard Palate	197
Zygomatic Bones	200
Nasal Bones	200
Palatine Bones	201
Inferior Nasal Conchae	201
Vomer	203
Lacrimal Bone	203
Bones of the Skull	204
Ethmoid	204
Frontal Bone	206
Parietal Bones	206
Temporal Bones	207
Occipital Bone	208
Sphenoid	209
Muscles of the Face	210
Orbicularis Oris	213
Transverse Muscles	214
Elevators	217
Depressors	221
Parallel Muscles: Incisivus Labii Superior and the Incisivus Labii Inferior	224

Supplementary Muscles of Facial Expression	224
Cavities of the Vocal Tract	226
The Oral Cavity	226
Buccal Cavities	237
Nasal Cavity	238
Pharynx	238
Muscles of the Tongue	239
Intrinsic Muscles of the Tongue	239
Extrinsic Muscles of the Tongue	241
Muscles of Mastication	246
Masseter (Figures 6–58 and 6–59)	246
Temporalis (Figures 6–58 and 6–60)	247
Medial Pterygoid (Figure 6–61)	247
Lateral Pterygoid (Figure 6–62)	249
Digastricus (Figures 6–58 and 6–63)	250
Mylohyoid (Figures 6–58 and 6–64)	251
Geniohyoid (Figures 6–53 and 6–58)	251
Platysma (Figure 6–34)	252
Muscles of the Velum	252
Elevators of the Velum	253
Depressors of the Velum	254
Muscles of the Pharynx	255
Pharyngeal Constrictors	255
Longitudinal Muscles of the Pharynx	259
Chapter Summary	262
References	264

## **7** **Physiology of Articulation and Resonance** **265**

Introduction to Articulation and Resonance	266
Physiology of Articulation and Resonance	266
Role of the Lips in Articulation	266
Role of the Tongue in Articulation	268
Role of the Muscles of the Tongue in Articulation	268
Role of the Tongue in Consonant Production	269
Role of the Tongue in Vowel Production	269
Role of the Teeth in Articulation	275
Role of the Mandible in Articulation	276
Role of Cheeks in Articulation and Resonance	279
Role of Velum in Articulation and Resonance	279
Role of the Pharynx in Articulation	282
Chapter Summary	284
References	285

## **8** **Physiology of Swallowing** **287**

Introduction to Swallowing	287
Process of Mastication and Deglutition	287
Oral Preparatory Stage Described	289

Oral Stage Described	291
Pharyngeal Stage Described	293
Esophageal Stage Described	297
Instrumentation	302
Videofluoroscopic Swallow Study/Modified Barium Swallow	302
Fiberoptic Endoscopic Evaluation of Swallow	303
High-Resolution Manometry	304
Changes With Age	305
Childhood Development	305
Changes With Normal Aging	307
Coordination of Respiration and Deglutition	309
Chapter Summary	309
References	312

## **9 Anatomy of Hearing 315**

Structures of the Auditory Mechanism	315
Outer Ear	316
Auricle	316
External Auditory Meatus	318
Tympanic Membrane	319
Middle Ear	321
Ossicles	321
Muscles of the Middle Ear	324
Landmarks of the Middle Ear Cavity	325
Inner Ear	326
Auditory System: Cochlea and Related Structures	327
Vestibular System	331
Vestibulocochlear Nerve (CN VIII)	332
Changes With Age (Presbycusis)	333
Chapter Summary	334
References	335

## **10 Physiology of Hearing and Balance 337**

Properties of Sound	338
Physiology of the Outer Ear	340
Pinna and External Auditory Meatus	340
Physiology of the Middle Ear	341
Movement of the Tympanic Membrane and the Ossicular Chain	341
Eustachian Tube	344
Physiology of the Inner Ear	345
Stimulation of the Cochlea	345
Transduction	348
Auditory Central Nervous System	351
Afferent Pathway	352
Efferent Pathway	353
Auditory Cortex: Auditory Processing and Speech Perception	353
Vestibular System	354



Instrumentation	355
Otoscopy	355
Pure Tone Audiometry	356
Speech Reception Threshold	357
Tympanometry	358
Acoustic Reflex Testing	358
Otoacoustic Emissions	359
Auditory Brainstem Response	360
Electrocochleography	360
Types of Hearing Loss	361
Conductive Hearing Loss	362
Sensorineural Hearing Loss	363
Mixed Hearing Loss	364
Chapter Summary	365
References	366

## **11 Neuroanatomy and Neurophysiology: Part 1 369**

Cells of the Nervous System	369
Neurons	370
Neuroglia	372
The Central Nervous System	375
The Brain	375
Chapter Summary	388
References	390

## **12 Neuroanatomy and Neurophysiology: Part 2 393**

The Lobes of the Cerebral Hemispheres	393
Frontal Lobes	394
Parietal Lobes	395
Temporal Lobes	396
The Occipital Lobes	398
Subcortical Structures	399
The Brainstem	399
The Cerebellum	402
The Thalamus	405
The Basal Ganglia	406
The Limbic System	408
The Spinal Cord	410
Blood Supply to the Brain	411
The Peripheral Nervous System	414
The Spinal Nerves	414
Chapter Summary	416
References	419

<i>Glossary</i>	421
<i>Index</i>	455

# Preface

It is with great pleasure that we introduce our new anatomy and physiology textbook for undergraduate programs in communication sciences and disorders. This book is the result of our passion for education and our commitment to the field of speech-language pathology and audiology. We are confident that this book will transform the way students learn anatomy and physiology. The inspiration for this book came from our experience with the Anatomage Virtual Dissection Table, which allowed us to view high-resolution images from virtual cadavers and propelled us to take on this project.

Before we embarked on this mission, we conducted a study with freshmen who had no prior class experience of anatomy and physiology related to speech-language pathology and found that the use of virtual dissection significantly improved their performance in tests and their understanding of anatomy. Encouraged by these results, we decided to write this textbook, which is filled with images from real cadavers, digitized and colored to target specific areas of the human body.

With our experience teaching the new generation of students, we have found that the majority of students skim through their anatomy textbooks because they are unable to process the vast amounts of information in paragraph form. Many students have mentioned that they struggle with integrating, synthesizing, and comprehending the information presented in paragraph form—resulting in a lack of retention of material and a resultant decreased performance on examinations and tests. Students today tend to break down paragraphs into bullet form for processing and consumption of the material and then integrate the details together visually using images.

This generation of students is also *technology dependent*; therefore, we listened to them and decided to write this book to make the learning process enjoyable for them. This text includes all the details of a traditional anatomy and physiology textbook but with unique pedagogical features to enhance the learning process. Our approach is image-heavy and includes a majority of high-resolution pictures from real cadavers. We introduce each topic in paragraph form, followed by information presented primarily in bullet form, which caters to the emerging needs of these students who spend vast amounts of time creating bulleted study guides. Immediate access to digital illustrative content that will supplement and enhance the students' understanding of the primary information is also provided adjacent to each topic. The book includes box features, key terms, chapter objectives, and chapter summaries.

The book comes with online ancillary materials for instructors and students. The student site includes interactive quizzes, vocabulary flashcards, a searchable image bank, and study guides. Instructors can download PowerPoint slides, a test bank, and an image bank, and can also access all of the student materials.

We are proud to say that this textbook is unlike other traditional anatomy and physiology textbooks. Professors who adopt it will immediately notice the difference. We are confident that our approach will boost student engagement and retention of material, leading to increased performance on examinations and tests. Our goal is to provide students with a comprehensive understanding of the human body and how it relates to communication disorders.

# Introduction

---

## ► Learning Objectives

---

Upon completion of this chapter, students will be able to:

- Understand foundational information about human anatomy and physiology and the use of anatomical nomenclature, orientation, and terms.
- Learn organs and systems of the human body, how they function, and their effects on speech, language, swallowing, cognitive, and hearing abilities.
- Understand the function of the 12 pairs of cranial nerves and how damage to these nerves can impact physiology.

## ► Key Terms

---

### Biology

The term *biology* originates from the Greek word *Bios* which means “life.” Biology is the study of living organisms. There are many specialty areas that fall under biology. These include cell biology, evolutionary biology, molecular biology, biochemistry, physiology, zoology, genetics, botany, and ecology. There is a great deal of overlap within these fields. Biology includes several constant factors: the study of evolution, heredity, consumption of energy, equilibrium, and cell theory. The human biological makeup includes cells, tissues, joints, organs, and systems. **Cell structures** are the basic units of the organism and are the building blocks of life. **Tissues** comprise many similar cells that are responsible for a particular function. **Organs** are formed by grouping several tissues. A **biological system** is a network or a group of two or more organs that combine to function together. **Joints** are where two bones are attached to allow body parts to move.

## Anatomy

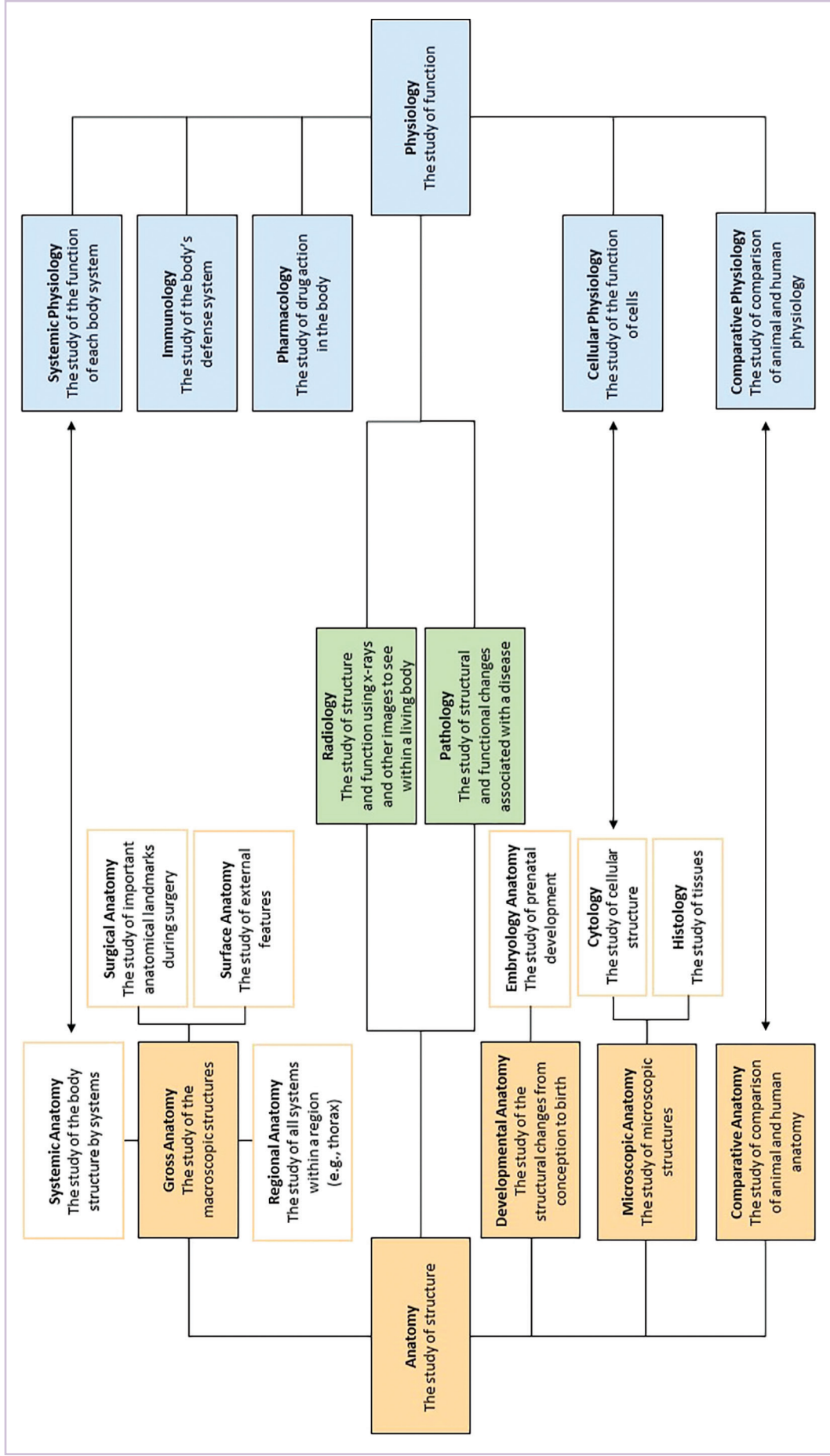
Anatomy is a branch of biology that studies the structures of organisms and their parts. Anatomy deals with dissection (e.g., human cadavers). The term *cadaver* is derived from the Latin verb—*cadere*, which means corpse. Anatomy has two divisions. The first is **macroscopic anatomy** or gross anatomy that uses unaided eyesight to study parts of an animal's body. Gross anatomy also includes superficial anatomy.

Initially, human anatomy was studied by superficially examining the wounds that soldiers sustained during war. Doctors later began to dissect bodies of dead soldiers to determine the cause of death. In the process of dissection, physicians were able to observe the relationships between body parts. In time, a second division of anatomy evolved—**microscopic anatomy**. This type of anatomy allows clinicians to use optical methods to observe structures and tissues inside a living person without dissection. Microscopic anatomy includes **histology**, which is the study of tissues under a light or electron microscope, and **cytology**, which is the study of cell structures and functions.

Within the field of anatomy, several specializations (Figure 1–1) have evolved:

- **Developmental anatomy**, also called **embryology**, studies how an embryo develops from a single cell to evolve into a human being. Embryology includes the study of prenatal and postnatal developmental changes and the processes by which these changes occur.
- **Surface anatomy**, also called **superficial anatomy**, **topographic anatomy**, or **regional anatomy**, studies the surfaces of human body structures. Surface anatomy is important for surgical procedures because it helps doctors identify the position of internal organs from the surface of the body. It establishes a relationship between deeper (internal) organs of the body and the surface of the body.
- **Comparative anatomy** is the study of similarities and differences in the structures of all living organisms. A comparative anatomist can study and compare the bones of humans, birds, chimpanzees, and frogs to look for similarities and differences to determine if various organisms share a common ancestor. Comparative anatomy also helps with classification of anatomical structures of organisms based on similarities. Comparative anatomy is mainly used in the field of paleontology (the study of animal and plant fossils).
- **General anatomy** is the study of gross and microscopic structures including different parts of the body, its fluids, and its tissues.
- **Descriptive anatomy** or **systematic anatomy** is the study of organ systems (e.g., respiratory system) that work together.
- **Applied anatomy** is also called **clinical** or **practical anatomy**. It is mainly concerned with the diagnosis and treatment of various conditions as well as the application of anatomical knowledge to specific fields (e.g., surgery).
- **Radiological anatomy** uses fluorography and radiography to study anatomy (e.g., x-rays).
- **Morbid anatomy**, also called **pathological anatomy**, is the study of diseased tissues.

**Anatomical variation** indicates that there are nonpathological structural anomalies that are different from normal. These differences do not indicate that there is any particular disorder. When looking more carefully at any given species, it should be noted that there is great variation between specimens. This variation does not necessarily mean that there will be differences in function. If there is a detrimental effect on functioning, then treatment may be required to rectify the impairment.



**FIGURE 1-1.** Specializations in anatomy.

## Physiology

Physiology is a subdiscipline of biology and includes the study of the functions of living organisms and their parts. Physiology examines how organs, organ systems, organisms, cells, and biomolecules carry out the chemical processes that are inherent in a living organism. One way of studying physiology is to use electroencephalography (EEG) to record electrophysiological activity in the brain. Electrodes are placed on the scalp, and voltage changes in the neurons of the brain can be measured. EEG is often used to diagnose sleep disorders, epilepsy, and other conditions as the EEG readings can show anomalies in brain waves.

Hippocrates, the *father of medicine*, is credited with discussing human physiology as far back as the fourth century BC. Claudius Galenus (AD 130–200), the founder of experimental physiology, was the first to document his experiments to examine the functions of the body; however, Jean Fernel (1497–1558) introduced the term *physiology*.

**Physiology** is divided into the following specialties:

- **Plant physiology** is a branch of botany. Plant physiologists study the functioning of plants, including respiration, nutrition, photosynthesis, germination, circadian rhythms, and other processes.
- **Microbial physiology** includes the study of bacteria, parasites, viruses, and fungi. It is used in the fields of metabolic engineering and functional genomics.
- **Cellular physiology** is the examination of factors that are responsible for keeping a cell alive (e.g., water in the roots of a plant).
- **Animal physiology** is the study of life-supporting processes, functions, and properties of blood flow, genetics, biological structure, regulation of temperature, and hormones in animals and humans.
- **Viral physiology** is the study of viruses.

## Anatomical Nomenclature

For centuries, those involved in the study of anatomy tried to develop a uniform method of assigning names to anatomical structures. By the late 19th century, there were over 50,000 terms for the parts of the body. What became confusing at times is that the same structures were called different names. Some of this confusion stemmed from the words that were derived from Latin or Greek origin or from where the anatomist was educated or country of origin.

In 1895, anatomists were interested in creating an international system of anatomical terminology and agreed on the Basle Nomina Anatomica (BNA). The result of this agreement was that the number of anatomical terms was reduced to 5,528. In 1955, the BNA was revised and updated, and the name was changed to Nomina Anatomica. Around 1985, there were some disagreements about terminology between the International Anatomical Nomenclature Committee and the International Federation of Associations of Anatomists (IFAA); therefore, in 1998, a new, simplified, updated, and uniform anatomical terminology was agreed upon by the IFAA that created a new committee, the Federative

Committee on Anatomical Terminology and introduced the term *Terminologia Anatomica* (TA). It is considered the international standard for anatomical terminology. *Gray's Anatomy* (2005) specifically recognizes TA (Standring, 2005).

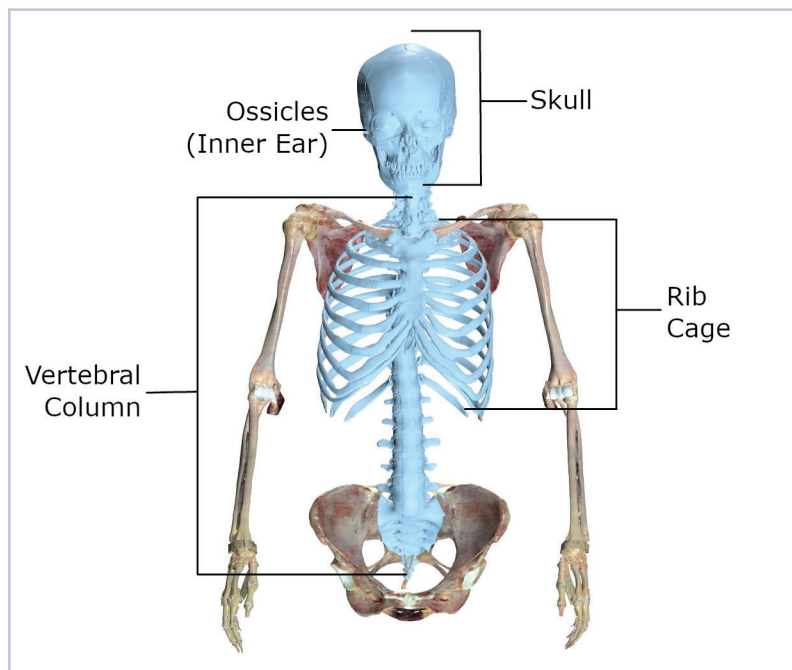
## Anatomical Orientation

To study the spatial relationships that exist in the human body, it is necessary to have a point of reference when discussing organs, bones, muscles, nerves, and other structures. The **axial skeleton** (Figure 1–2) comprises the bones of the trunk and the head. In humans, the axial skeleton consists of 80 bones (vertebral column, hyoid bone, skull bones, rib cage, sternum, and ossicles of the middle ear). The entire human skeleton includes the axial skeleton and the **appendicular skeleton** (126 bones) (Figure 1–3). The word *appendicular* is derived from appendage (joined to something). The appendicular skeleton includes the limbs as well as the skeletal structures in the limbs, the pelvic girdles, and the pectoral girdles (also known as the shoulder girdles)—these form the complete skeleton (White et al., 2012).

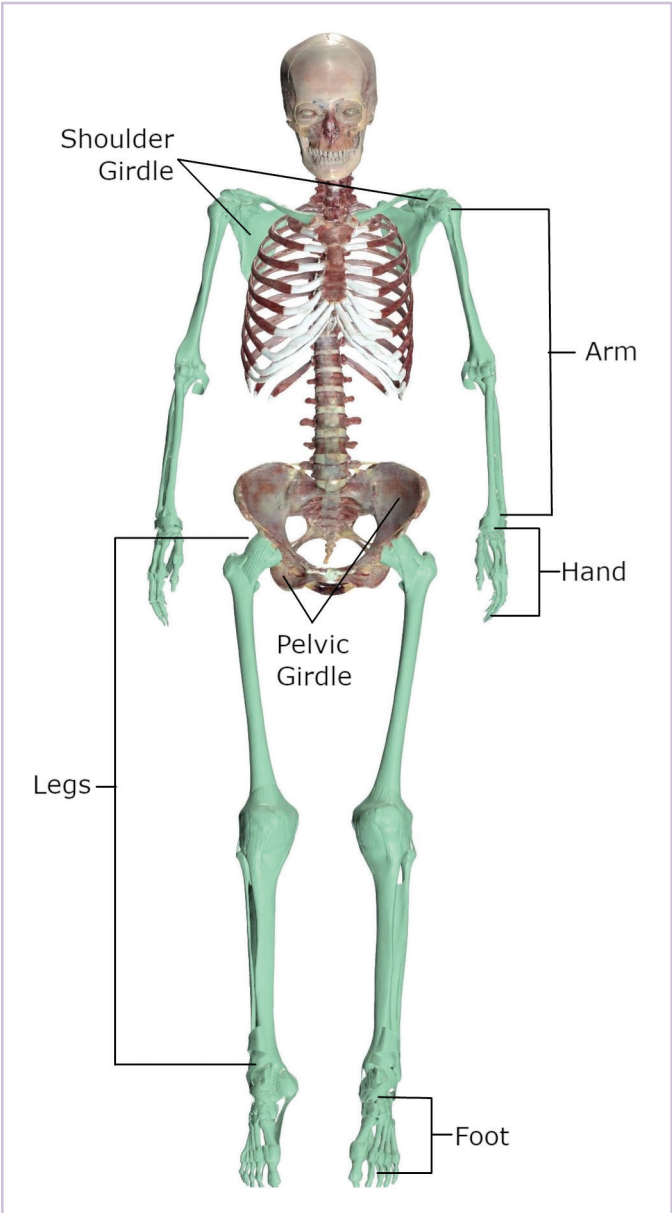
This point of reference is the **standard anatomical position** where the body is at rest and standing erect with the feet together or slightly apart. The face is directed forward. The arms are at the side and rotated outward, with the palms facing forward. The thumbs are pointed away from the body (Tortora & Derrickson, 2006).

## Anatomical Terms

Contrasting pairs of terms for common locations and for anatomical surfaces are listed next and displayed in Table 1–1 and Figure 1–4.



**FIGURE 1–2.** Axial skeleton. Reproduced with permission from Anatomage.



**FIGURE 1-3.** Appendicular skeleton. Reproduced with permission from Anatomage.



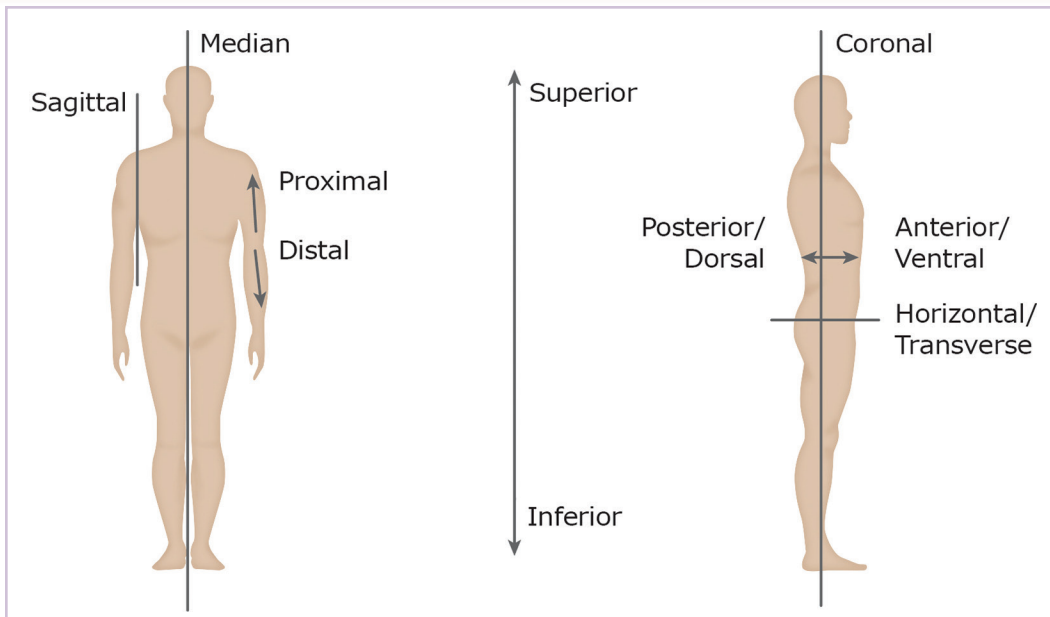
**TABLE 1-1.** Contrasting Pairs of Terms

<b>Anterior</b> (ventral)—front of the body (away from the back)	<b>Posterior</b> (dorsal)—back of the body (away from the front)
<b>Adduction</b> —moving toward the midline	<b>Abduction</b> —moving away from the midline
<b>Agonists</b> —muscles that can cause movement because of their own contraction	<b>Antagonists</b> —muscles that oppose a particular movement
<b>Central</b> —situated at the center	<b>Peripheral</b> —situated at the edge
<b>Contralateral</b> —opposite side	<b>Ipsilateral</b> —same side
<b>Dorsal</b> —away from the front of the body	<b>Ventral</b> —toward the front of the body
<b>Endo</b> —inner	<b>Ecto</b> —outer
<b>Flexion</b> —bending of a body part	<b>Extension</b> —straightening of a body part
<b>Inferior</b> —below another body part	<b>Superior</b> —above another body part
<b>Infra</b> —below	<b>Supra</b> —above
<b>Internal</b> (deep)—inside	<b>External</b> (superficial)—outside
<b>Intrinsic</b> —within the organ	<b>Extrinsic</b> —from the outside
<b>Ipsilateral</b> —affecting the same side of the body as the site of the lesion	<b>Contralateral</b> —affecting the opposite side of the body from the site of the lesion
<b>Medial</b> —closer to the axis or midline	<b>Lateral</b> —away from the axis or midline
<b>Prone</b> —lying flat, facedown	<b>Supine</b> —lying face upward
<b>Protraction</b> —moving a body part forward (jutting out the chin)	<b>Retraction</b> —pulling a body part backward (pulling the chin in)
<b>Proximal</b> —near to the center of the body	<b>Distal</b> —away from the center of the body
<b>Rostral</b> (cranial)—toward the nose, mouth, and head (usually refers to the structures in the cranium)	<b>Caudal</b> —posterior of the body (toward the tailbone)
<b>Superficial</b> —toward the surface of the body	<b>Deep</b> —away from the surface of the body

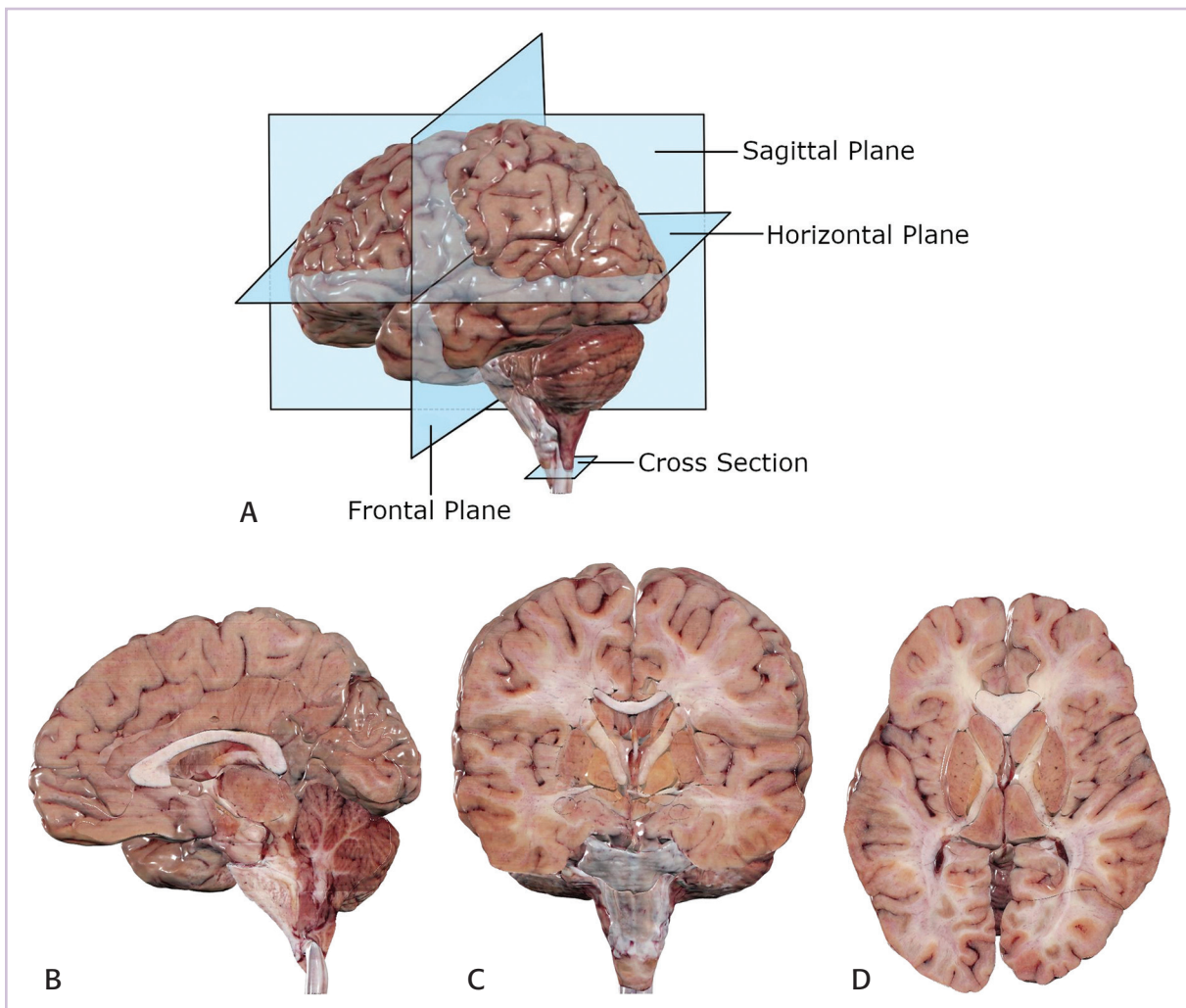
The human body has axes (singular *axis*) or midlines that give rise to other structures. These are two-dimensional sections of the body. There are three main planes (axes) of the body. These planes are imaginary two-dimensional surfaces that pass through the body (Figure 1-5).

The **sagittal/vertical plane** divides the body into right and left sides vertically. It is named after the sagittal suture that runs from the front to the back of the top of the skull. If this plane courses down the middle of the body, it is called the *median* or *midsagittal* plane; however, it is known as the *longitudinal* section or *parasagittal* plane if it divides the body into unequal right and left sides.

The **frontal/coronal plane** divides the body into ventral/anterior (belly) and dorsal/posterior (back). It is named after the coronal suture that separates the frontal and parietal bones of the skull. This is a longitudinal plane because it is perpendicular to the transverse plane.



**FIGURE 1-4.** Planes (axes) of reference and anatomical terms.



**FIGURE 1-5.** A. Sagittal/frontal/horizontal plane. B. Sagittal/vertical plane. C. Frontal/coronal plane. D. Horizontal plane. A–D reproduced with permission from Anatomage.