SNELL'S CLINICAL ANATOMY BY REGIONS

ELEVENTH EDITION

LAWRENCE E. WINESKI

Wolters Kluwer

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Preface

I am honored to continue the authorship of this new edition of Dr. Richard S. Snell's textbook of anatomy. I hope this 11th edition meets Dr. Snell's high standards and will continue his legacy of scholarship and clinical relevance in teaching.

This book provides health science students with a review of basic anatomy in a strong clinical context. It includes the following changes:

1. The number of chapters has been reduced. Certain previously separate chapters (eg, Thoracic Wall and Thoracic Cavity) have been merged into single chapters without reducing content.
2. The progression of topics has been revised within certain chapters, beginning with foundational material and building more complex relations. For example, discussion of the joints of the upper limb now is in immediate proximity to the description of the bones.
3. The text has been largely reworked throughout and now includes new material and updated terminology. New tables provide succinct summaries of information.
4. Many new and/or updated illustrations better demonstrate points of anatomy, especially those related to organizational concepts.

Each chapter follows a similar format. This makes it easier to locate material and facilitates moving from one part of the book to another. Each chapter centers on the following categories:

1. **Clinical Example:** A short case report that dramatizes the relevance of anatomy in medicine introduces the chapter.
2. **Learning Objectives:** These enable the student to focus on the primary anatomy that is most important to learn and understand.
3. **Basic Clinical Anatomy:** The bulk of the chapter provides basic information on gross anatomic structures of clinical importance. Clinical and Embryology Notes supplement the core text, indicate clinical applications, and explain adult morphology and major congenital malformations.
4. **Radiographic Anatomy:** Each chapter includes numerous standard medical images (eg, radiographs, CT scans, MRI studies, and sonograms) to demonstrate normal anatomy in the manner most often observed by clinicians. Labeled photographs of cross-sectional anatomy stimulate students to think in terms of three-dimensional anatomy, which is so important in the interpretation of imaging studies.
5. **Surface Anatomy:** This outlines surface landmarks and palpation points of important anatomic structures fundamental to a thorough physical examination.
6. **Key Concepts:** This closing part of the chapter summarizes the major points of anatomy discussed in the chapter to reinforce the topics covered.
7. **Review Questions:** A collection of review questions is available online at https://thepoint.lww.com/student. The purpose of these questions is threefold: to focus attention on areas of importance, to enable students to assess their areas of strengths and weaknesses, and to provide a form of self-evaluation for questions asked under examination conditions. The questions are in the National Board format and center around a clinical problem that requires an anatomic answer.

As with previous editions, the book is heavily illustrated. Most figures have been kept simple in order to convey the fundamental floor plans that underlie the organization of body regions. Many new illustrations have been added. These include an emphasis on organizational schemes and diversity in patient populations.

L.E.W.

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Finally, I wish to express my deep gratitude to the staff of Wolters Kluwer for their great help and support in the preparation of this new edition. My special thanks to Crystal Taylor (Acquisitions Editor) for the opportunity of authorship and the freedom to revise as I felt was appropriate, to Kelly Horvath (Freelance Development Editor) for exceptional editing and concept discussions, and to Deborah Bordeaux (Development Editor) and Erin Hernandez (Editorial Coordinator) for steering this project to completion. I also thank Jennifer Clements for revisions to Dr. Snell's artwork. I especially thank Lionel Williams for his insight and artistry in developing and implementing the numerous original new illustrations in this edition.

Contents

1 Introduction

A 65-year-old male was admitted to the emergency department with the sudden onset of a severe crushing pain over the front of his chest, spreading down his left arm and up into his neck and jaw. On questioning, he said that he had had several attacks of pain before and that they had always occurred when he was climbing stairs or digging in the garden. Previously, he found that the discomfort disappeared with rest after about 5 minutes. However, on this occasion, the pain was more severe and had occurred spontaneously while he was sitting in a chair. Additionally, the pain had not abated.

See the Clinical Case Discussion at the end of this chapter for further insight.

CHAPTER OUTLINE

LEARNING OBJECTIVES

The purpose of this chapter is to introduce the primary terminology used in describing the position and movement of the human body, some of the basic structures that compose the body (eg, skin, fascia, muscles, and bones), and the principles of medical imaging.

1. Define the anatomic position, major planes of section, and primary terms of direction used in anatomic descriptions.
2. Define the primary movements utilized in anatomic descriptions.
3. Identify the components of the skin and its appendages.
4. Identify the types and distributions of the fasciae of the body.
5. Identify the main structural features of bone. Describe bone classification systems. Describe the developmental processes of bone formation.
6. Identify the major forms of cartilage and the locations where each form is generally found.
7. Identify the major categories of joints and the structures that characterize each type of joint. Provide examples of each type of joint. Identify the structures responsible for maintaining the stability of joints.
8. Define and differentiate a bursa versus a synovial sheath.
9. Identify the three types of muscle and describe the basic structure of each type. Define the terms used to describe the actions of skeletal muscles. Describe the pattern of innervation of skeletal muscles and the parameters used in naming them.
10. Identify the major subdivisions of the nervous system. Describe the components of a typical spinal nerve. Trace the distribution of a typical spinal nerve.

11. Describe the general organization of the autonomic nervous system. Differentiate between sympathetic and parasympathetic components and pathways, and preganglionic and postganglionic elements.
12. Define a dermatome. Contrast this with the cutaneous territory of a peripheral nerve.
13. Identify the main types of blood vessels and their functional roles in transporting blood.
14. Identify the components of the lymphatic system. Trace the major routes of lymph drainage in the body.
15. Identify and differentiate mucous and serous membranes.
16. Describe the general sex-, age-, and ethnicity-related differences in anatomic form.
17. Describe the major steps in embryonic development. Differentiate ectoderm, endoderm, and mesoderm, and identify the main derivatives of each.
18. Identify the primary forms of medical imaging and the characteristics of images formed by each technique.

GENERAL ORIENTATION

Anatomy is the science of the structure and function of the body. **Clinical anatomy** is the study of the macroscopic structure and function of the body as it relates to the practice of medicine and other health sciences.

Anatomic Terminology

It is essential to understand the terms used for describing the structures in different regions of the body because without these terms, it is impossible to describe the composition of the body in a meaningful way. Clinicians also need these terms so that anatomic abnormalities found on the clinical examination of a patient can be accurately recorded. The accurate use of anatomic terms by medical personnel enables them to communicate with their colleagues both nationally and internationally.

Understanding anatomic terminology (with the aid of a medical dictionary) rather than memorizing rote nomenclature greatly assists you in the learning process. Without anatomic terms, abnormal functions of joints, the actions of muscles, the alteration of position of organs, or the exact location of swellings or tumors cannot be accurately discussed or recorded.

Terms Related to Position

Spatial orientation and organization are crucial concepts in anatomy, and understanding the standard geometric references that allow uniform, clear descriptions of locations, relations, and movements of structures is important. All descriptions of the human body are based on a conventional reference posture termed the **anatomic position**. In this, a person is standing erect and facing forward, the upper limbs are by the sides, the palms of the hands are directed forward, the lower limbs are together, the soles of the feet are on the ground, and the toes are pointing forward (Fig. 1.1). All directional and movement descriptions are based on this body position. Four geometric planes, three of which are at right angles to the others, are applied to the body in the anatomic position.

- The **median plane** is a vertical plane passing through the center of the body, dividing it into equal right and left halves (see Fig. 1.1A).
- A **sagittal plane** is any plane parallel to the median plane that divides the body into unequal right and left portions.
- The **coronal** (**frontal**) **plane** is a vertical plane situated at a right angle to the median plane. The coronal plane divides the body into the anterior (front) and posterior (back) portions.
- The **horizontal plane** lies at right angles to both the median and the coronal planes. A horizontal plane divides the body into the upper and lower parts.
- A **transverse plane** lies perpendicular to the long axis of a given structure and divides that structure in a cross-sectional orientation. The terms "transverse plane" and "horizontal plane" are often used interchangeably. However, they are not necessarily equivalent. Consider the difference between the horizontal and transverse planes in the leg versus the foot and in the abdomen versus the gut tube. Understand that these planes in such regions produce very different orientations of the structures in question.

The terms **anterior** (**ventral**) and **posterior** (**dorsal**) are used to indicate the front and back of the body, respectively (see Fig. 1.1B). To describe the relationship of two structures, one is said to be anterior or posterior to the other, insofar as it is comparatively closer to the anterior or posterior body surface (eg, the nose is on the anterior side of the head, whereas the buttocks are on the posterior side of the body). In describing the hand, the terms **palmar** and **dorsal** surfaces are used in place of anterior and posterior, respectively. In describing the foot, the term **plantar** surface refers to the sole of the foot, and the **dorsal** surface indicates the upper (top) surface (see Fig. 1.1C).

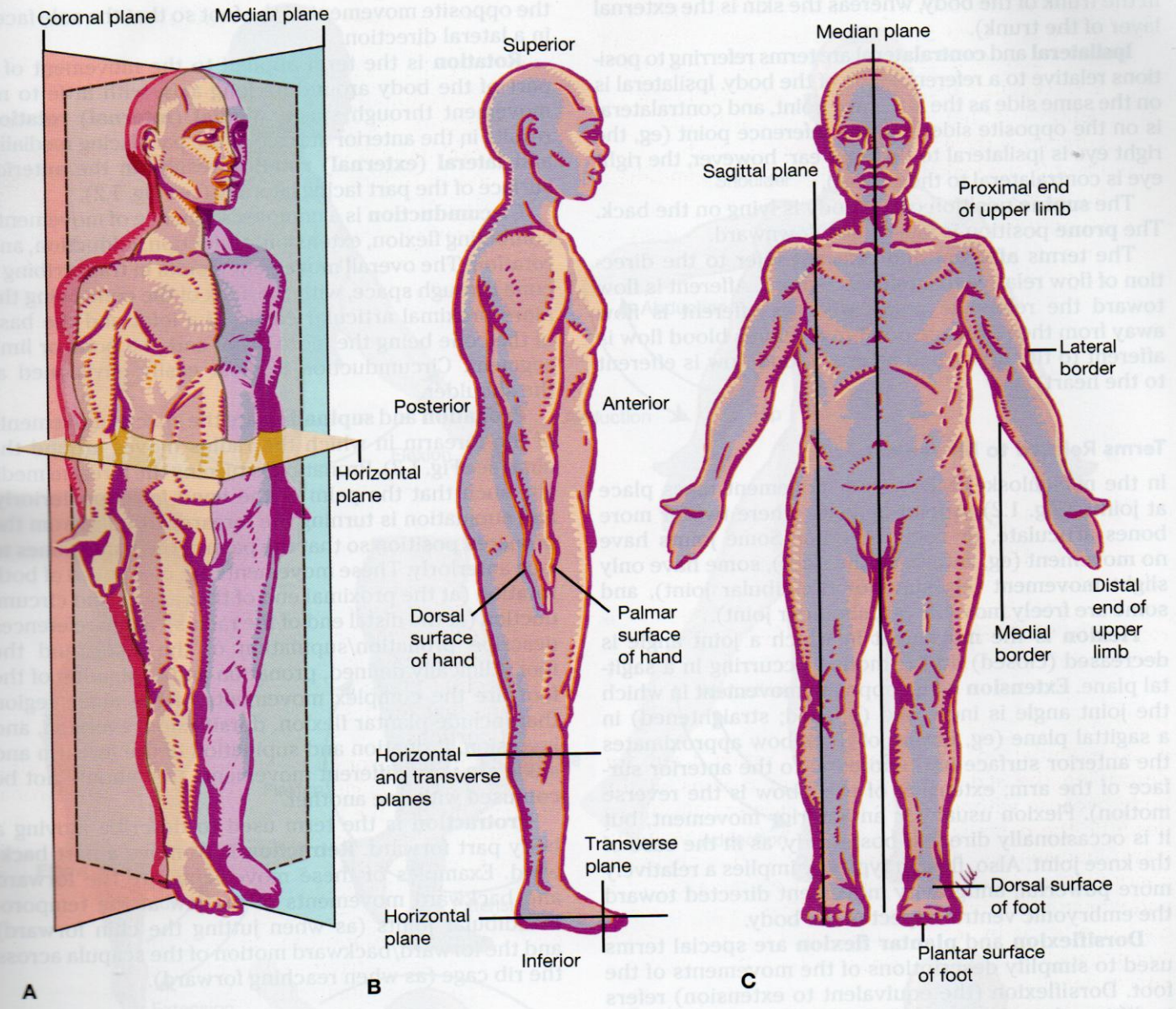

Figure 1.1 Anatomic terms used in relation to position. Note that the subjects are standing in the anatomic position. **A.** Illustration of the median, coronal, and horizontal planes. Note that these planes are aligned at 90° to one another. **B.** Lateral view, demonstrating anatomic planes and directional terms. Note that the horizontal and transverse planes may or may not be equivalent. **C.** Anterior view, showing planes of section and anatomic directions.

A structure situated nearer to the median plane of the body than another is said to be **medial** to the other. Similarly, a structure that lies farther away from the median plane than another is said to be **lateral** to the other (eg, in the head, the eyes are lateral to the nose, and the nose is medial to the eyes).

The terms **superior** (**cranial**; **cephalic**) and **inferior** (**caudal**) denote the levels relatively high or low with reference to the upper and lower ends of the body (eg, the head is at the superior end of the body, whereas the feet are at the inferior end of the body).

The terms **proximal** and **distal** describe positions relative to the core, root, or attached end of a reference point. Proximal is closer to the core, and distal is further away from the core (eg, in the upper limb, the shoulder is proximal to the elbow, and the hand is distal to the elbow).

The terms **superficial** and **deep** denote positions relative to the surface of the body or a given structure. Superficial is closer to the surface, whereas deep is farther away from the surface (eg, the skin is superficial to the ribs, but the heart is deep to the ribs).

The terms **internal** and **external** are used to describe locations relative to the center of a structure or space. Internal is inside the structure, and external is outside the structure (eg, the thoracic cavity is an internal space

in the trunk of the body, whereas the skin is the external layer of the trunk).

Ipsilateral and **contralateral** are terms referring to positions relative to a reference side of the body. Ipsilateral is on the same side as the reference point, and contralateral is on the opposite side from the reference point (eg, the right eye is ipsilateral to the right ear; however, the right eye is contralateral to the left ear).

The **supine** position of the body is lying on the back. The **prone** position is laying face downward.

*The terms **afferent** and **efferent** refer to the direction of flow relative to a reference point. Afferent is flow toward the reference point, whereas efferent is flow* away from the reference point (eg, venous blood flow is afferent to the heart, and arterial blood flow is efferent to the heart).

Terms Related to Movement

In the musculoskeletal system, movement takes place at joints (Fig. 1.2). A joint is a site where two or more bones articulate, or come together. Some joints have no movement (eg, sutures of the skull), some have only slight movement (eg, superior tibiofibular joint), and some are freely movable (eg, shoulder joint).

Flexion is the movement in which a joint angle is decreased (closed) during motion occurring in a sagittal plane. **Extension** is the opposite movement in which the joint angle is increased (opened; straightened) in a sagittal plane (eg, flexion of the elbow approximates the anterior surface of the forearm to the anterior surface of the arm; extension of the elbow is the reverse motion). Flexion usually is an anterior movement, but it is occasionally directed posteriorly, as in the case of the knee joint. Also, flexion typically implies a relatively more powerful, antigravity movement directed toward the embryonic ventral aspect of the body.

Dorsiflexion and **plantar flexion** are special terms used to simplify descriptions of the movements of the foot. Dorsiflexion (the equivalent to extension) refers to lifting the top of the foot superiorly, toward the shin. Plantar flexion (the equivalent to flexion) refers to moving the sole of the foot inferiorly, as in standing on the toes. These points will become clearer in the following chapters on the back and limbs. "Lateral flexion" is an imprecise term sometimes used in clinical settings that refers to a sideways bending movement of the trunk in the coronal plane (Fig. 1.3). However, "abduction" is the more correct term and the one that should be used.

Abduction is movement away from the midline of the body in the coronal plane. **Adduction** is movement toward the midline of the body in the coronal plane (see Fig. 1.2). In the fingers and toes, abduction is applied to spreading apart the digits, and adduction is applied to drawing them together. The movements of the thumb, which are more complicated, are described in Chapter 3.

Inversion and **eversion** are the special terms used to describe certain movements of the foot (see Fig. 1.3). Inversion is turning the sole of the foot so that it faces in a medial direction, toward the midline, and eversion is the opposite movement of the foot so that the sole faces in a lateral direction.

Rotation is the term applied to the movement of a part of the body around its long axis, with little to no movement through space. **Medial (internal) rotation** results in the anterior surface of the part facing medially, and **lateral (external) rotation** results in the anterior surface of the part facing laterally (see Fig. 1.2).

Circumduction is a complex sequence of movements combining flexion, extension, abduction, adduction, and *rotation. The overall movement results in transcribing a* cone through space, with the apex of the cone being the *more proximal articular cavity of a joint and the base* of the cone being the more distal end of a bone or limb segment. Circumduction is most easily envisioned at the shoulder.

Pronation and **supination** are the special movements of the forearm in which the radius moves around the ulna (see Fig. 1.3). Pronation is turning the forearm medially such that the palm of the hand faces posteriorly, and supination is turning the forearm laterally from the pronated position so that the palm of the hand comes to face anteriorly. These movements are composed of both rotation (at the proximal end of the radius) and circumduction (at the distal end of the radius). Some references describe pronation/supination of the ankle and the foot. Clinically defined, pronation and supination of the foot are the complex movements of the ankle region that include plantar flexion, dorsiflexion, eversion, and inversion. Pronation and supination of the forearm and ankle are very different movements that should not be confused with one another.

Protraction is the term used to describe moving a body part forward. **Retraction** is to move a part backward. Examples of these movements are the forward and backward movements of the jaw at the temporomandibular joints (as when jutting the chin forward) and the forward/backward motion of the scapula across the rib cage (as when reaching forward).

Eponyms

International commissions reflecting the views of multiple professional anatomic societies determine official anatomic terminology. One of the guidelines used in producing this *Terminologica Anatomica* is that eponyms shall not be used. In a scientific context, an eponym is an identifying term formed from the name of a person (eg, ampere, volt, foramen of Winslow, and circle of Willis). However, eponyms are used randomly, conveying no information about the structure in question, and they are often historically misleading in that the person honored by the naming did not necessarily contribute the first description of the structure (eg, François Poupart was not the first to describe the inguinal ligament). Unfortunately, eponyms remain in wide use in the biomedical sciences, especially in clinical settings. Newer generations of anatomists and other health science professionals should adopt current official terminology and avoid eponyms whenever possible to reverse this trend.

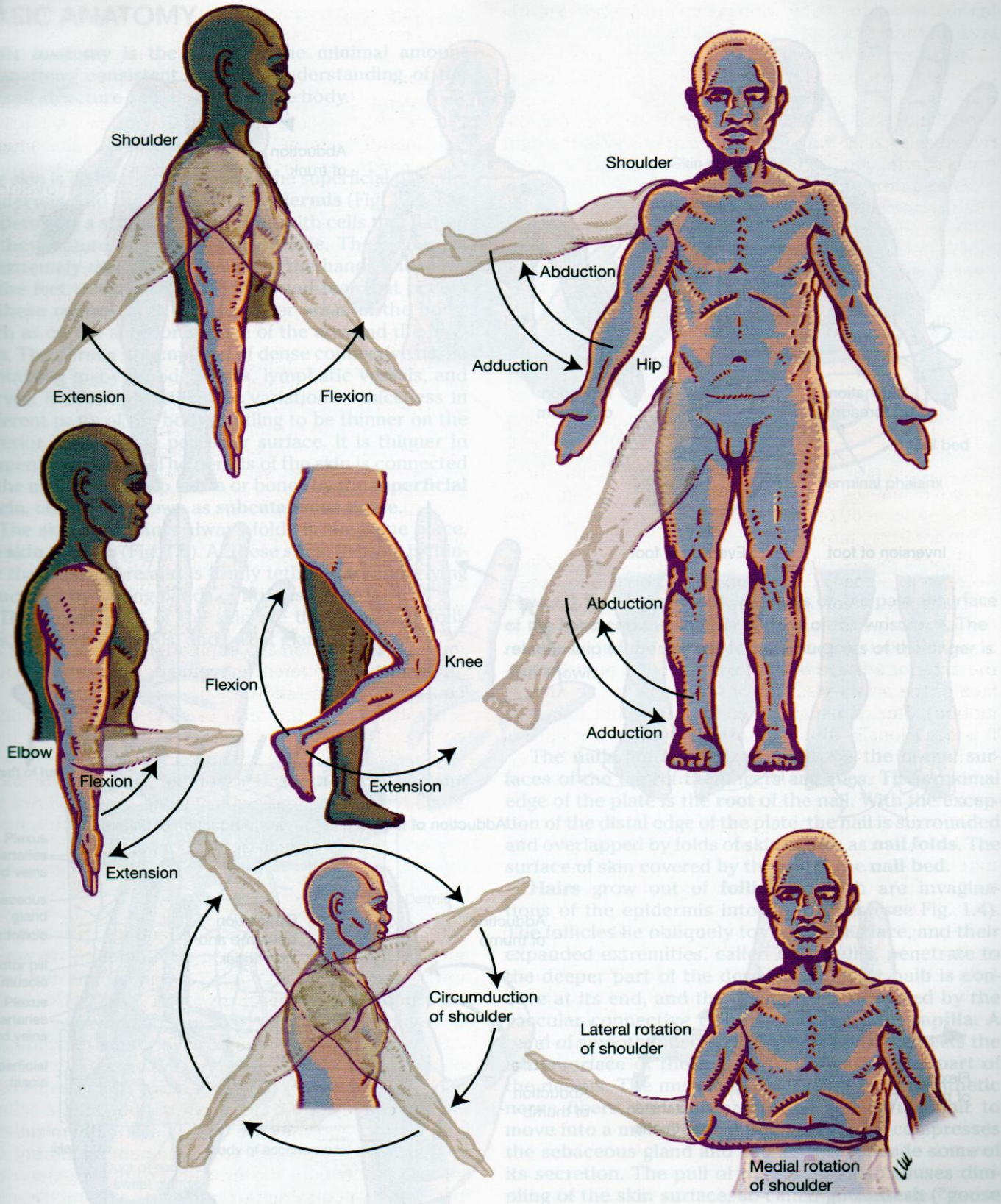

Figure 1.2 Some anatomic terms used in relation to movement. Note the difference between flexion of the elbow versus the knee.

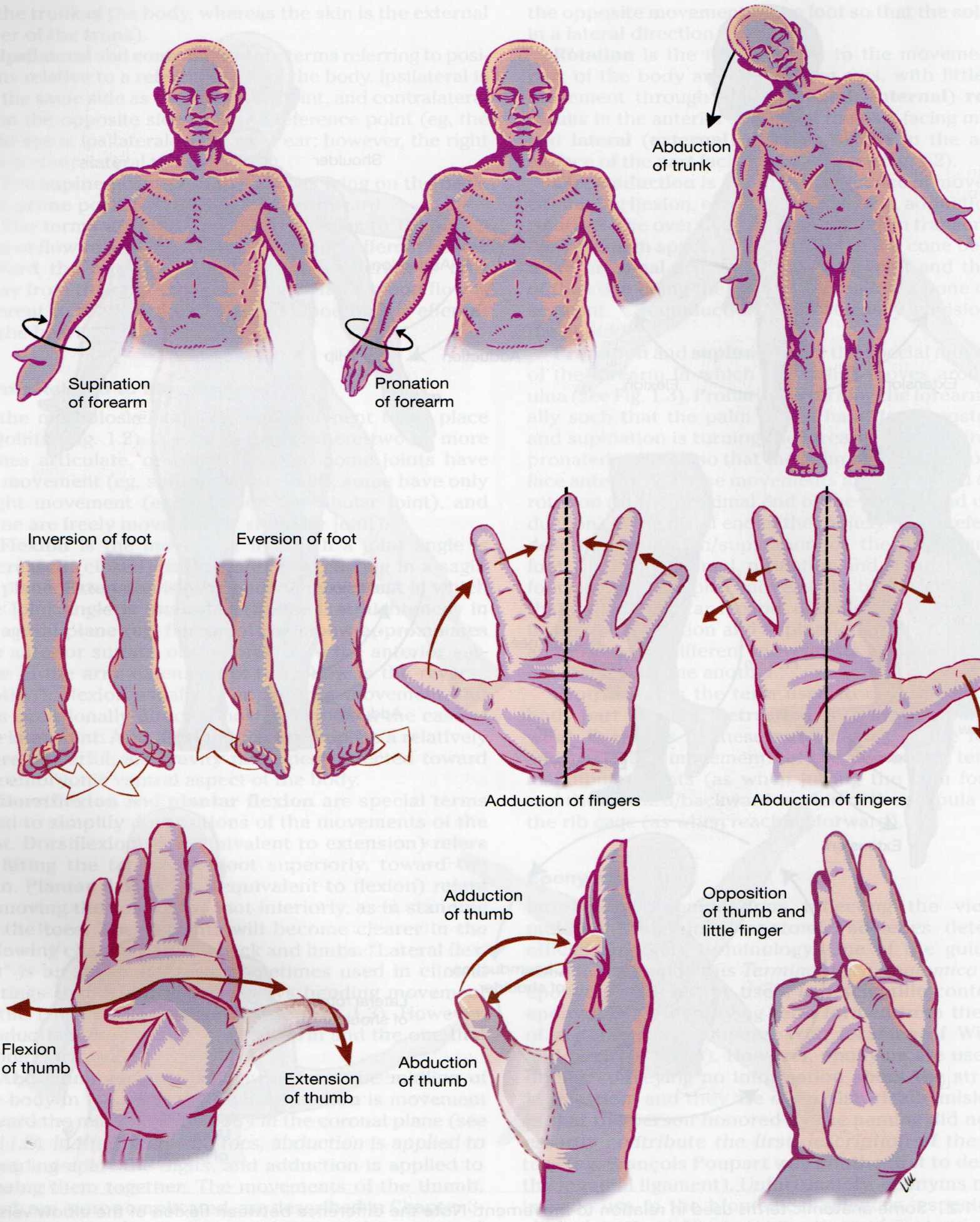

Figure 1.3 Additional anatomic terms used in relation to movement.