Anatomical Language

Objectives

After completing this exercise, you should be able to:
- Describe the anatomical position
- Identify major body regions on models or charts
- Use anatomical terms correctly
- Use directional terms correctly
- Identify body planes and sections on models, charts, or preserved specimens

Materials

- human models or anatomical charts
- articulated skeleton
- 5 sheep brains (for class demonstration)
- apples (1 per group) and plastic knives
- plastic tubing (1-foot piece per group)

Students often complain that they are not just learning anatomy but are learning a new language. This is quite true since most anatomical terms are derived from Latin and Greek word roots. In this exercise, you will learn anatomical terms for body structures that will be used throughout the course and will help you communicate effectively with other health care professionals.

A. Anatomical Position

The anatomical position is the reference position anatomists and people in medical fields use to describe the location of body parts or regions. In the anatomical position, the body is erect and facing forward; the arms are straight and at the sides of the body with the palms facing forward; the legs are straight with the feet facing forward and flat (Figure 1.1).

ACTIVITY 1 Anatomical Position

1. Assume the anatomical position.
2. Have your laboratory partner determine if you are in the correct position.

B. Body Regions

The main body regions are described in Table 1.1. It is important that you learn the correct boundaries for each region. Two common misconceptions are that the arm is the area between the shoulder and wrist and that the leg includes the thigh. Actually, the arm is located between the shoulder and elbow, and the forearm is located from the elbow to wrist. The thigh is located between the groin and knee, and the leg is located between the knee and ankle.
FIGURE 1.1 Body regions.

(a) Anterior view

1 ______________________
2 ______________________
3 ______________________
4 ______________________
5 ______________________

(b) Posterior view

6 ______________________
7 ______________________
8 ______________________
9 ______________________
10 ______________________
11 ______________________
12 ______________________
13 ______________________
14 ______________________
### TABLE 1.1  Body Regions

<table>
<thead>
<tr>
<th>BODY REGION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>Bony portion of head</td>
</tr>
<tr>
<td>Skull</td>
<td>Portion of skull not normally covered by scalp</td>
</tr>
<tr>
<td>Face</td>
<td>Body area between head and trunk</td>
</tr>
<tr>
<td>Neck</td>
<td>Central body area to which head and limbs are attached</td>
</tr>
<tr>
<td>Trunk</td>
<td>Area of trunk between neck and abdomen; contains heart and lungs; diaphragm forms boundary between chest and abdomen</td>
</tr>
<tr>
<td>Chest</td>
<td>Area of trunk between chest and pelvis; contains digestive organs; hip bones form lower boundary of abdomen</td>
</tr>
<tr>
<td>Abdomen</td>
<td>Area of trunk below abdomen; contains internal reproductive organs and urinary bladder</td>
</tr>
<tr>
<td>Pelvis</td>
<td>Posterior portion of trunk between neck and buttocks</td>
</tr>
<tr>
<td>Back</td>
<td>Curved area where arm attaches to upper border of trunk</td>
</tr>
<tr>
<td>Armpit</td>
<td>Under-arm area where upper limb attaches to trunk</td>
</tr>
<tr>
<td>Arm</td>
<td>Area of upper limb between shoulder and elbow</td>
</tr>
<tr>
<td>Forearm</td>
<td>Area of upper limb between elbow and wrist</td>
</tr>
<tr>
<td>Wrist</td>
<td>Portion of hand that connects hand to forearm</td>
</tr>
<tr>
<td>Hand</td>
<td>Includes wrist and fingers</td>
</tr>
<tr>
<td>Lower Limb</td>
<td>Rounded area on posterior surface where thigh attaches to trunk</td>
</tr>
<tr>
<td>Buttocks</td>
<td>Area where lower limb attaches to the pelvis</td>
</tr>
<tr>
<td>Groin</td>
<td>Area of lower limb above the knee</td>
</tr>
<tr>
<td>Thigh</td>
<td>Area of lower limb between knee and ankle</td>
</tr>
<tr>
<td>Leg</td>
<td>Portion of foot that connects foot to leg</td>
</tr>
<tr>
<td>Ankle</td>
<td>Includes ankle and toes</td>
</tr>
</tbody>
</table>

### ACTIVITY 2  Body Regions

1. Label Figure 1.1 with the appropriate body regions. Use terms from Table 1.1.
2. Identify body regions on models or anatomical charts. Use terms from Table 1.1.

### C. Anatomical Terms

Anatomical terms describe body regions, specific body areas, and landmarks. Most of these words are derived from Latin or Greek and are often part of the names of muscles, bones, nerves, and blood vessels. Learning these terms at this time will help you throughout the course.

Many anatomical terms have one or more word roots with a prefix and/or a suffix added. For example, in the word *antebrachial*, *ante-* is a prefix meaning before or in front of; the word root *cubit-* means elbow; *-al* is a suffix meaning pertaining to. Table 1.2 contains anatomical terms with four different suffixes all of which mean pertaining to. These suffixes are: *-al*, *-ic*, *-ar*, and *-ary*. When suffixes like these are added to word roots, they form adjectives, whereas nouns have different endings, such as *-um*, *-us*, *-is*, and *-a*. For example, *stern-* is a word root meaning chest; *sternum* is the noun and *sternal* is the adjective. Anatomical terms and their definitions are found in Table 1.2. Word roots and their definitions are found in Appendix B, as well as nouns and adjectives formed from the word roots.

### ACTIVITY 3  Anatomical Terms

1. Label Figure 1.2 with the appropriate anatomical terms for each body region or area. Refer to Table 1.2.
2. Use anatomical terms to identify the specific body regions or areas on models or anatomical charts.
3. Pronounce the anatomical terms as you point to them on models or anatomical charts.
4. Print out the glossary of prefixes, suffixes, and word roots from the book’s companion web site (www.wiley.com/college/allen) for use as a reference.
<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
<th>TERM</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AXIAL</strong></td>
<td>Pertaining to the central part of the body, the head and trunk</td>
<td><strong>APPENDICULAR</strong></td>
<td>Pertaining to the extremities or limbs</td>
</tr>
<tr>
<td><strong>Cephalic</strong> (se-FAL-ik)</td>
<td>Pertaining to the head</td>
<td><strong>Upper Limb (Appendage)</strong></td>
<td>Pertaining to the highest point of the shoulder</td>
</tr>
<tr>
<td>• Facial</td>
<td>Pertaining to the forehead</td>
<td>• Axillary (AX-il-ary)</td>
<td>Pertaining to the armpit</td>
</tr>
<tr>
<td>• Frontal</td>
<td>Pertaining to the eye</td>
<td>• Brachial (BRAY-key-ul)</td>
<td>Pertaining to the arm</td>
</tr>
<tr>
<td>• Orbital</td>
<td>Pertaining to the nose</td>
<td>• Cubital</td>
<td>Pertaining to the elbow</td>
</tr>
<tr>
<td>• Otic (OH-тик)</td>
<td>Pertaining to the cheek</td>
<td>• Antecubital (an-teh-KYOO-bi-tul)</td>
<td>Pertaining to the anterior (front) surface of the elbow</td>
</tr>
<tr>
<td>• Nasal</td>
<td>Pertaining to the mouth</td>
<td>• Olecranal (oh-LEK-ra-nul)</td>
<td>Pertaining to the posterior (back) surface of the elbow</td>
</tr>
<tr>
<td>• Buccal (BUCK-al)</td>
<td>Pertaining to the chin</td>
<td>• Antebrachial</td>
<td>Pertaining to the forearm</td>
</tr>
<tr>
<td>• Oral</td>
<td>Pertaining to the portion of the skull surrounding the brain</td>
<td>• Carpal</td>
<td>Pertaining to the wrist</td>
</tr>
<tr>
<td>• Mental</td>
<td>Pertaining to the back of head</td>
<td>• Manual</td>
<td>Pertaining to the hand</td>
</tr>
<tr>
<td>• Cranial</td>
<td>Pertaining to the neck</td>
<td>• Palmar</td>
<td>Pertaining to the palm of the hand</td>
</tr>
<tr>
<td>• Occipital (ox-SIP-i-tal)</td>
<td>Pertaining to the chest</td>
<td></td>
<td>Pertaining to the digits (fingers)</td>
</tr>
<tr>
<td><strong>Cervical</strong></td>
<td>Pertaining to the breast</td>
<td><strong>Lower Limb (Appendage)</strong></td>
<td>Pertaining to the groin where the thigh attaches to the pelvis</td>
</tr>
<tr>
<td><strong>Thoracic</strong></td>
<td>Pertaining to the breast bone</td>
<td>• Inguinal (ING-won-ul)</td>
<td>Pertaining to the buttocks</td>
</tr>
<tr>
<td>• Pectoral (PEK-tore-al)</td>
<td>Pertaining to the abdomen</td>
<td>• Gluteal (GLUE-tee-ul)</td>
<td>Pertaining to the thigh</td>
</tr>
<tr>
<td>• Sternal</td>
<td>Pertaining to the navel</td>
<td>• Femoral (FEM-or-ul)</td>
<td>Pertaining to the anterior (front) surface of the knee</td>
</tr>
<tr>
<td><strong>Abdominal</strong></td>
<td>Pertaining to the hip</td>
<td>• Patellar (pa-TEL-ur)</td>
<td>Pertaining to the posterior (back) surface of the knee</td>
</tr>
<tr>
<td>• Umbilical (um-BIL-ih-cal)</td>
<td>Pertaining to the pelvis</td>
<td>• Popliteal (pop-IL-ih-TEE-ul)</td>
<td>Pertaining to the anterior (front) surface of the leg</td>
</tr>
<tr>
<td>• Coxal (COX-al)</td>
<td>Pertaining to the genital area</td>
<td>• Crural (CROO-rul)</td>
<td>Pertaining to the posterior (back) surface of the leg</td>
</tr>
<tr>
<td><strong>Pelvic</strong></td>
<td>Pertaining to the back</td>
<td>• Sural (SIIR-ul)</td>
<td>Pertaining to the lateral side of the leg</td>
</tr>
<tr>
<td>• Pubic (PYOO-bik)</td>
<td>Pertaining to the shoulder blade region</td>
<td>• Fibular (FIIB-you-lur) or peroneal (peh-RONE-ee-ul)</td>
<td>Pertaining to the ankle</td>
</tr>
<tr>
<td><strong>Dorsal</strong></td>
<td>Pertaining to the spinal column</td>
<td>• Tarsal (TAR-sul)</td>
<td>Pertaining to the foot</td>
</tr>
<tr>
<td>• Scapular</td>
<td>Pertaining to the area of the back between the lowest rib and buttocks</td>
<td>• Pedal</td>
<td>Pertaining to the heel</td>
</tr>
<tr>
<td>• Vertebral (ver-TEE-brul)</td>
<td></td>
<td>• Calcaneal (kal-KANE-ee-ul)</td>
<td>Pertaining to the sole of foot</td>
</tr>
<tr>
<td>• Lumbar</td>
<td></td>
<td>• Plantar</td>
<td>Pertaining to the digits (toes)</td>
</tr>
</tbody>
</table>
D. Directional Terms

Directional terms are used to describe the location of body structures relative to other structures. An example of a directional term is inferior, which means below. It would be correct to say that the neck is inferior to the head but incorrect to say that the neck is inferior to the brain. The directional terms are listed in Table 1.3, along with an example of how they are used. Note that opposite terms are paired.

The directional terms proximal and distal apply to the point of attachment of a limb to the torso or the point of origin of a structure such as a blood vessel or nerve. These terms refer to the location of structures relative to the point of attachment or point of origin, whether they are closer (proximal) or farther away (distal).

**Activity 4** Directional Terms

1. Complete the sentences using the appropriate directional term from Table 1.3.
   a. The sternum is _________ to the vertebrae.
   b. The orbit is _________ to the oral cavity.
   c. The heart is _________ to the lungs.
   d. The carpus is _________ to the brachium.
   e. The right lung and right kidney are _________
   f. The skin is _________ to the bones.

2. Label Figure 1.3 with directional terms.

**Table 1.3** Directional Terms

<table>
<thead>
<tr>
<th>Directional Term</th>
<th>Definition</th>
<th>Example of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior (Cephalic)</td>
<td>Above</td>
<td>The head is superior to the neck.</td>
</tr>
<tr>
<td>Inferior (Caudal)</td>
<td>Below</td>
<td>The neck is inferior to the head.</td>
</tr>
<tr>
<td>Anterior (Ventral)</td>
<td>Closer to front of body</td>
<td>The lips are anterior to the teeth.</td>
</tr>
<tr>
<td>Posterior (Dorsal)</td>
<td>Closer to back of body</td>
<td>The teeth are posterior to the lips.</td>
</tr>
<tr>
<td>Medial</td>
<td>Closer to midline of body</td>
<td>The nose is medial to the eyes.</td>
</tr>
<tr>
<td>Lateral</td>
<td>Farther from midline of body</td>
<td>The eyes are lateral to the nose.</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Between two structures</td>
<td>The elbow is intermediate between the shoulder and wrist.</td>
</tr>
<tr>
<td>Ipsilateral</td>
<td>On same side of body</td>
<td>The right arm and right leg are ipsilateral.</td>
</tr>
<tr>
<td>Contralateral</td>
<td>On opposite sides of body</td>
<td>The right arm and left arm are contralateral.</td>
</tr>
<tr>
<td>Proximal</td>
<td>Nearer to point of attachment of limb to trunk</td>
<td>The elbow is proximal to the wrist.</td>
</tr>
<tr>
<td>Distal</td>
<td>Farther from point of attachment of limb to trunk</td>
<td>The wrist is distal to the elbow.</td>
</tr>
<tr>
<td>Superficial</td>
<td>Closer to surface of body</td>
<td>The skin is superficial to the muscles.</td>
</tr>
<tr>
<td>Deep</td>
<td>Farther from surface of body</td>
<td>The muscles are deep to the skin.</td>
</tr>
</tbody>
</table>
E. Body Planes and Sections

Planes divide the body or organs in order to observe internal structures (Figure 1.4). The exposed surfaces produced by planes are called sections. Sagittal (sagitta = arrow) planes pass vertically through the body or organs and divide them into right and left sections (sagittal sections). If a plane passes vertically through the midline and divides the body into equal right and left halves, the plane is a midsagittal plane, but if a plane divides the body into unequal right and left portions it is a parasagittal plane. A frontal or coronal plane passes vertically through the body or organs and produces anterior and posterior sections (frontal sections). A transverse plane passes horizontally through the body and produces superior and inferior sections (transverse sections or cross-sections). Oblique planes pass through the body at an angle-forming oblique sections.

We often look at sections of individual organs, such as blood vessels, intestines, or long bones. Sections that are produced by a plane running along the long axis of a long narrow structure are called longitudinal sections. Sections that are produced by a plane running perpendicular to the long axis are called cross-sections. Because blood vessels and intestines twist and bend, one body plane may produce longitudinal sections, cross-sections, and oblique sections of these structures.

**CLINICAL NOTE:** Transverse sections observed with computed tomography (CT) scans or magnetic resonance imaging (MRIs) are called axial sections.

**ACTIVITY 5** Body Planes and Sections

1 Label the planes in Figures 1.4(a) and (b).
2 Observe sagittal, frontal, and transverse sections using an apple.
   - Working in a group, draw a face on the apple.
   - Cut sagittal, frontal, and transverse planes through the apple to make sagittal, frontal, and transverse sections.
   - Observe the appearance of the apple core in each section.
   - Keep sections together to form a whole apple to show to your instructor.

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**FIGURE 1.4** Planes through the human body.

- frontal plane
- midsagittal plane
- oblique plane
- parasagittal plane
- transverse plane
3 Observe how one plane can produce both longitudinal sections and cross-sections through a tube.
   - Observe a demonstration of a tube cut in a longitudinal section and in a cross-section.
   - Twist a 1-foot section of plastic tubing so that one plane will divide one area of the tube into a longitudinal section and another area into a cross-section.
   - Do not cut the tube unless instructed to do so.
   - Show your instructor where a cut would produce both a longitudinal section and a cross-section.

4 Demonstrate sagittal, frontal, transverse, and oblique sections on sheep brains.
   - Your instructor will display five sheep brains—one whole brain and four brains that have been cut into different sections.

   - Determine the anterior, posterior, superior, and inferior surfaces of the brains.
   - Decide which brain has been cut into sagittal, frontal, transverse, or oblique sections.
   - Compare the appearance of the different sections.

   Brain 1—Whole brain
   Brain 2 ____________ section
   Brain 3 ____________ section
   Brain 4 ____________ section
   Brain 5 ____________ section
Reviewing Your Knowledge

A. Anatomy Drill and Practice

Go to www.wiley.com/college/allen. Click on your lab manual, Student Companion Site, Anatomy Drill and Practice, and Exercise 1.

B. Anatomical Position

The person in Figure 1.5 is not in anatomical position. List four differences from anatomical position.

![Person Not in Anatomical Position](image)

**FIGURE 1.5** Person not in anatomical position.

1
2
3
4
C. Anatomical Terms for Body Structures

Write the anatomical terms that the phrase or word describes. Phrases or words referring to nouns are indicated. All other phrases refer to adjectives.

1. Navel (noun).
2. Pertaining to the area between the neck and abdomen.
3. Pertaining to the ear.
4. Pertaining to the palm of hand.
5. Pertaining to the high point of the shoulder.
6. Pertaining to the anterior surface of the elbow region.
7. Pertaining to the face; anterior portion of the head.
8. Pertaining to the nose.
9. Pertaining to the neck.
10. Pertaining to the posterior surface of the knee.
11. Wrist (noun).
12. Pertaining to the area between the elbow and wrist.
15. Pertaining to the mouth.
16. Pertaining to the anterior surface of the knee.
17. Breast bone (noun).
18. Pertaining to the hip.
19. Pertaining to the side of the leg.
20. Pertaining to the calf.
21. Pertaining to the area between the shoulder and elbow.
22. Pertaining to the fingers or toes.
23. Pertaining to the hand.
24. Pertaining to the breast area.
25. Pertaining to the cheek.
26. Pertaining to the heel.
27. Pertaining to the sole of the foot.
28. Pertaining to the groin where the thigh attaches to the pelvic region.
29. Pertaining to the head.
30. Pertaining to the chin.
31. Pertaining to the foot.
32. Pertaining to the eye.
33. Pertaining to the genital area.
34. Pertaining to the area between the hip and knee.
35. Pertaining to the area that includes the bones enclosing the brain but excluding the facial bones.
36. Pertaining to the forehead.
37. Pertaining to the spinal column.
38. Pertaining to the inferior back of the head.
39. Pertaining to the anterior surface of the leg.
40. Pertaining to the area of the lower back or loin.
41. Pertaining to the anterior trunk below the abdomen.
42. Pertaining to the area of the back that contains the shoulder blades.
43. Pertaining to the posterior surface of the elbow region.
44. Arm (noun).

D. Body Planes and Sections

Write the name of the plane that the phrase describes.

1. Divides body or organ into unequal right and left sections.
2. Divides body or organ into anterior and posterior sections.
3. Divides body or organ into superior and inferior sections.
4. Divides body into right and left halves.
5. Which planes when passed through the body would result in two sections, with each section containing a piece of the heart and a piece of each lung?
E. Directional Terms

Complete the sentences using directional terms. Use Figure 1.6 for reference.

1. The clavicle is ________ to the ribs.

2. The ribs are ________ to the sternum.

3. The humerus is ________ to the radius.

4. The ulna is ________ to the radius.

5. The tibia is ________ to the femur.

6. The right humerus and the right radius are ________

7. The pelvic girdle is ________ to the ribs.

8. The sternum is ________ to the vertebral column.

9. The scapula is ________ to the clavicle.

10. The right fibula and left fibula are ________.
<table>
<thead>
<tr>
<th>Joint</th>
<th>Characteristics and Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibrous Joints</td>
<td></td>
</tr>
<tr>
<td>Sutures (fig. 10.4)</td>
<td>Immovable fibrous joints between cranial and facial bones</td>
</tr>
<tr>
<td>Serrate suture</td>
<td>Bones joined by a wavy line formed by interlocking teeth along the margins. Examples: coronal, sagittal, and lambdoid sutures</td>
</tr>
<tr>
<td>Lap suture</td>
<td>Bones beveled to overlap each other; superficial appearance is a smooth line. Example: squamous suture around temporal bone</td>
</tr>
<tr>
<td>Plane suture</td>
<td>Bones buttressed against each other without overlapping or interlocking. Example: palatine suture</td>
</tr>
<tr>
<td>Gomphosis (fig. 10.3b)</td>
<td>Insertion of a tooth into a socket, held in place by collagen fibers of periodontal ligament</td>
</tr>
<tr>
<td>Syndesmosis (fig. 10.3c)</td>
<td>Slightly movable joint held together by ligaments or interosseous membranes. Examples: tibiofibular joint and radioulnar joint</td>
</tr>
<tr>
<td>Cartilaginous Joints</td>
<td></td>
</tr>
<tr>
<td>Synchondrosis (fig. 10.5a)</td>
<td>Adjacent bones bound by cartilage</td>
</tr>
<tr>
<td>Symphysis (fig. 10.5b, c)</td>
<td>Bones held together by hyaline cartilage. Examples: articulation of ribs with sternum, and epiphyseal plate uniting the epiphysis and diaphysis of a long bone of a child</td>
</tr>
<tr>
<td>Synostoses</td>
<td>Slightly movable joint held together by fibrocartilage. Examples: intervertebral discs and pubic symphysis</td>
</tr>
<tr>
<td>Synovial Joints (figs. 10.6 and 10.8)</td>
<td>Adjacent bones covered with hyaline articular cartilage, separated by lubricating synovial fluid and enclosed in a fibrous joint capsule</td>
</tr>
<tr>
<td>Ball-and-socket</td>
<td>Multiaxial diarthrosis in which a smooth hemispherical head of one bone fits into a cuplike depression of another. Examples: shoulder and hip joints</td>
</tr>
<tr>
<td>Hinge</td>
<td>Monaxial diarthrosis, able to flex and extend in only one plane. Examples: elbow, knee, and interphalangeal joints</td>
</tr>
<tr>
<td>Saddle</td>
<td>Joint in which each bone surface is saddle-shaped (concave on one axis and convex on the perpendicular axis). Unique to the thumb (trapeziometacarpal joint), where it allows opposition (touching of the thumb to the fingertips)</td>
</tr>
<tr>
<td>Pivot</td>
<td>Joint in which a projection of one bone fits into a ringlike ligament of another, allowing one bone to rotate on its longitudinal axis. Examples: atlantoaxial joint and proximal radioulnar joint</td>
</tr>
<tr>
<td>Gliding</td>
<td>Synovial amphiarthrosis with slightly concave or convex bone surfaces that slide across each other. Examples: intercarpal, intertarsal, and sternoclavicular/ joints; joints between the articular processes of the vertebrae</td>
</tr>
<tr>
<td>Condyloid</td>
<td>Blaxial diarthrosis in which an oval convex surface of one bone articulates with an elliptical depression of another. Examples: radiocarpal and metacarpophalangeal joints</td>
</tr>
</tbody>
</table>

In Table 10.1 the joints are classified by structural criteria. Some joints are difficult to classify, however, because they have elements of more than one type. The jaw joint, for example, has some aspects of condyloid, hinge, and gliding joints for reasons that will be apparent later.

**Movements of Diarthroses**

In physical therapy, kinesiology, and other medical and scientific fields, specific terms are used to describe the
movements of diarthroses. You will need a command of these terms to understand the muscle actions in the next chapter. In the following discussion, many of them are grouped to describe opposite or contrasting movements.

**Flexion, Extension, and Hyperextension**

Flexion (figs. 10.9 and 10.10c) is movement that decreases the angle of a joint, usually in a sagittal plane. Examples are bending the elbow or knee and bending the neck to look down at the floor. Bending at the wrist, as if taking a bow, is flexion of the spine. Flexion of the shoulder consists of raising the arm from anatomical position in a sagittal plane, as if to point in front of you or toward the ceiling. Flexion of the hip entails raising the thigh, as in a high-stepping marching stance.

Extension is movement that straightens a joint and generally returns a body part to anatomical position—for example, straightening the elbow or knee, raising the head to look directly forward, straightening the waist, or moving the arm back to a position parallel to the trunk.

Hyperextension is the extension of a joint beyond 180°. For example, if you extend your arm and hand with the palm down, and then raise the back of your hand as if admiring a new ring, you are hyperextending the wrist. If you look up toward the ceiling, you are hyperextending your neck. If you move your arm to a position posterior to the shoulder, you are hyperextending your shoulder.

**Think About It**

Some synovial joints have articular surfaces or ligaments that prevent them from being hyperextended. Try hyperextending some of your synovial joints and list a few for which this is impossible.

**Abduction and Adduction**

Abduction\(^\text{12}\) (ab-DUC-shun) (fig 10.10) is movement of a body part away from the midsagittal line—for example, raising the arm to one side of the body or standing spread-legged. To abduct the fingers is to spread them apart. Adduction\(^\text{13}\) (ah-DUC-shun) is movement toward the midsagittal line or median axis of the middle digit—

\(^{12}\) ab = away + duc = to carry, lead

\(^{13}\) ad = toward + duc = to carry, lead

---

**Figure 10.9** Types of Joint Movement. (a) Flexion of the elbow; (b) extension of the elbow; (c) flexion of the wrist; (d) extension of the wrist; (e) hyperextension of the wrist; (f) flexion of the spine; (g) extension of the spine and flexion of the shoulder; (h) hyperextension of the neck and shoulder.
Figure 10.10 Types of Joint Movement, Continued. (a) Abduction of the arms and legs; (b) adduction of the arms and legs; (c) abduction (lateral flexion) of the spine; (d) abduction of the fingers; (e) adduction of the fingers.

Figure 10.11 Types of Joint Movement, Continued. (a) Elevation of the shoulders; (b) depression of the shoulders; (c) protraction of the mandible; (d) retraction of the mandible; (e) lateral excursion of the mandible; (f) medial excursion of the mandible.
that is, returning the body part to anatomical position. Some movements are open to alternative interpretations. Bending the head to one side or bending sideways at the waist may be regarded as abduction or lateral flexion.

**Elevation and Depression**

Elevation (fig. 10.11a) is movement that raises a bone vertically. The mandible is elevated when biting off a piece of food, and the clavicles are elevated when shrugging the shoulders as if to gesture, “I don’t know.” The opposite of elevation is depression—lowering the mandible to open the mouth or lowering the shoulders, for example (fig. 10.11b).

**Protraction and Retraction**

Protraction\(^{14}\) is movement of a bone anteriorly (forward) on a horizontal plane, and retraction\(^{15}\) is movement posteriorly (fig. 10.11c, d). Jutting the jaw outward, lurching the shoulders forward, or thrusting the pelvis forward are examples of protraction. The clavicles are retracted when standing at military attention. Most people have some degree of overbite and so must protract the mandible to make the incisors meet when taking a bite of fruit, for example. The mandible is then retracted to make the molars meet and grind food between them.

**Lateral and Medial Excursion**

Biting and chewing food require several movements of the jaw: up and down (elevation-depression), forward and back (protraction-retraction), and side-to-side grinding movements. The last of these are called lateral excursion (sideways movement to the right or left) and medial excursion (movement back to the midline) (fig. 10.11e, f).

**Circumduction**

Circumduction\(^{18}\) (fig. 10.12a) is movement in which one end of an appendage remains relatively stationary while the other end makes a circular motion. The appendage as a whole thus describes a conical space. For example, if an artist standing at an easel reaches out and draws a circle on the canvas, the shoulder remains stationary while the hand makes a circle. The extremity as a whole thus exhibits circumduction. A baseball player winding up for the pitch circumducts the arm in a more extreme “windmill” fashion. Circumduction is actually a sequence of flexion, abduction, extension, and adduction.

\(^{14}\) pro = forward + trac = pull, draw  
\(^{15}\) re = back + tract = pull, draw  
\(^{16}\) circum = around + duc = to carry, lead

**Rotation**

Rotation is a movement in which a bone turns on its longitudinal axis. Figure 10.12 shows the limb movements that occur in lateral and medial rotation of the femur and humerus. Twisting at the waist is rotation of the trunk. When the head is turned from side to side, the atlas rotates on the axis.

**Supination and Pronation**

These movements are limited to the forearm. Supination\(^{17}\) (SOO-pih-NAY-shun) (fig. 10.13a) is rotation of the forearm so that the palm faces forward or upward; in anatomical position, the forearm is supine. Pronation\(^{18}\) (fig. 10.13b) is rotation of the forearm so that the palm faces toward the rear or downward. As an aid to memory, think of it this way: you are prone to stand in the most comfortable position, which is with the palm pronated. If you were holding a bowl of soup in your hand, your forearm would have to be supinated. These movements are achieved with muscles discussed in the next chapter. The supinator muscle is the most powerful, and supination is the sort of movement you would usually make with the right hand to turn a doorknob clockwise or drive a screw into a piece of wood.

**Opposition and Reposition**

Opposition\(^{19}\) is movement of the thumb to approach or touch the fingertips, and reposition\(^{20}\) is its movement back to anatomical position, parallel to the index finger (fig. 10.13c, d). Opposition is the movement that enables the hand to grasp objects and is the single most important hand function.

**Dorsiflexion and Plantar Flexion**

These movements are limited to the foot. Dorsiflexion (DOR-sih-FLEK-shun) is a movement in which the toes are raised (as one might do to apply toenail polish) (fig. 10.14a). The foot is dorsiflexed in each step you take as your foot comes forward. Dorsiflexion prevents your toes from scraping on the ground and results in a “heel strike” when that foot touches down in front of you. Plantar (PLAN-tur) flexion is extension of the foot so that the toes point downward, as in standing on tiptoe or pressing the gas pedal of a car (fig. 10.14c). This motion also produces the “toe-off” in each step you take, as the heel of the foot behind you lifts off the ground.

17. supin = to lay back  
18. pron = to bend forward  
19. op = against + posit = to place  
20. re = back + posit = to place
Inversion and Eversion

These movements are also unique to the feet (fig. 10.14d, e). Inversion\(^{21}\) is a movement in which the soles are turned medially; eversion\(^{22}\) is a turning of the soles to face laterally. Inversion and eversion are common in fast sports such as tennis and football and often result in ankle sprains. These terms also refer to congenital deformities of the feet, which are often corrected by orthopedic shoes or braces.

\(21.\) \textit{in} = inward + \textit{version} = turning
\(22.\) \textit{e} = outward + \textit{version} = turning

\textbf{Think About It}

A chimpanzee sitting on the ground reaches out and grasps an object between its fingertips. Then it raises its hand to its face and turns the object to examine it. List the movements that would occur at its diarthroses and identify the joint at which each one would occur.

Range of Motion

We can see from the movements just described that the range of motion (ROM) of a joint varies greatly from one type to another. ROM obviously affects a person's functional...
Figure 10.13 Types of Joint Movement Unique to the Upper Limb. (a) Supination of the forearm; (b) pronation of the forearm; (c) opposition of the thumb; (d) reposition of the thumb.

independence and quality of life. It is also an important consideration in training for athletics or dance, in clinical diagnosis, and in monitoring the progress of rehabilitation. ROM can be measured with a simple device called a goniometer23 (fig. 10.15).

Several factors affect the ROM and stability of a joint:

- **Structure and action of the muscles.** The two most important factors in stabilizing a joint are tendons and muscle tone (a state of partial contraction of a "resting" muscle). Tendons, ligaments, and muscles have sensory nerve endings called proprioceptors (PRO-pree-oh-SEP-turs) that continually monitor joint angle and muscle tension. Upon receiving this information, the spinal cord sends nerve signals back to the muscles to increase or decrease their state of contraction and adjust the position of the joint and tautness of the tendons.

Figure 10.14 Types of Joint Movement Unique to the Foot. (a) Dorsiflexion; (b) extension; (c) plantar flexion; (d) inversion; and (e) eversion.

Figure 10.15 Measuring Range of Motion (ROM). The goniometer measures the angle through which a person can move a joint.
Figure 5.1  Points of muscle attachment

(A) ____________________________

Definition: ____________________________

(B) ____________________________

Definition: ____________________________

Figure 5.2 ____________________________

Figure 5.3 ____________________________

Figure 5.4 ____________________________

Figure 5.5 ____________________________