

The **control center**, which determines the level (set point) at which a variable is to be maintained, analyzes the information it receives and then determines the appropriate response or course of action.

The third component is the **effector**, which provides the means for the control center's response (output) to the stimulus. Information flows from the control center to the effector along the *efferent pathway*. (*Efferent* information *exits* from the control center.) The results of the response then *feed back* to influence the stimulus, either by depressing it (negative feedback) so that the whole control mechanism is shut off or by enhancing it (positive feedback) so that the reaction continues at an even faster rate.

Most homeostatic control mechanisms are **negative feedback mechanisms**. In such systems, the net effect of the response to the stimulus is to shut off the original stimulus or reduce its intensity. A frequently used example of a negative feedback system is a home heating system connected to a thermostat. In this situation, the thermostat contains both the receptor and the control center. If the thermostat is set at 20°C (68°F), the heating system (effector) will be triggered ON when the house temperature drops below that setting. As the furnace produces heat, the air is warmed. When the temperature reaches 20°C or slightly higher, the thermostat sends a signal to shut off the furnace. Your body “thermostat,” located in a part of your brain called the *hypothalamus*, operates in a similar way to regulate body temperature. Other negative feedback mechanisms regulate heart rate, blood pressure, breathing rate, and blood levels of glucose, oxygen, carbon dioxide, and minerals.

Because they tend to increase the original disturbance (stimulus) and to push the variable *farther* from its original value, **positive feedback mechanisms** are rare in the body. Typically these mechanisms control infrequent events that occur explosively and do not require continuous adjustments. Blood clotting and the birth of a baby are the most familiar examples of positive feedback mechanisms.



### Homeostatic Imbalance

Homeostasis is so important that most disease can be regarded as a result of its disturbance, a

condition called **homeostatic imbalance**. As we age, our body organs become less efficient, and our internal conditions become less and less stable. These events place us at an increasing risk for illness and produce the changes we associate with aging.

Examples of homeostatic imbalance will be provided throughout this book to enhance your understanding of normal physiological mechanisms. These homeostatic imbalance sections are preceded by the symbol ▲ to alert you that an abnormal condition is being described. ▲

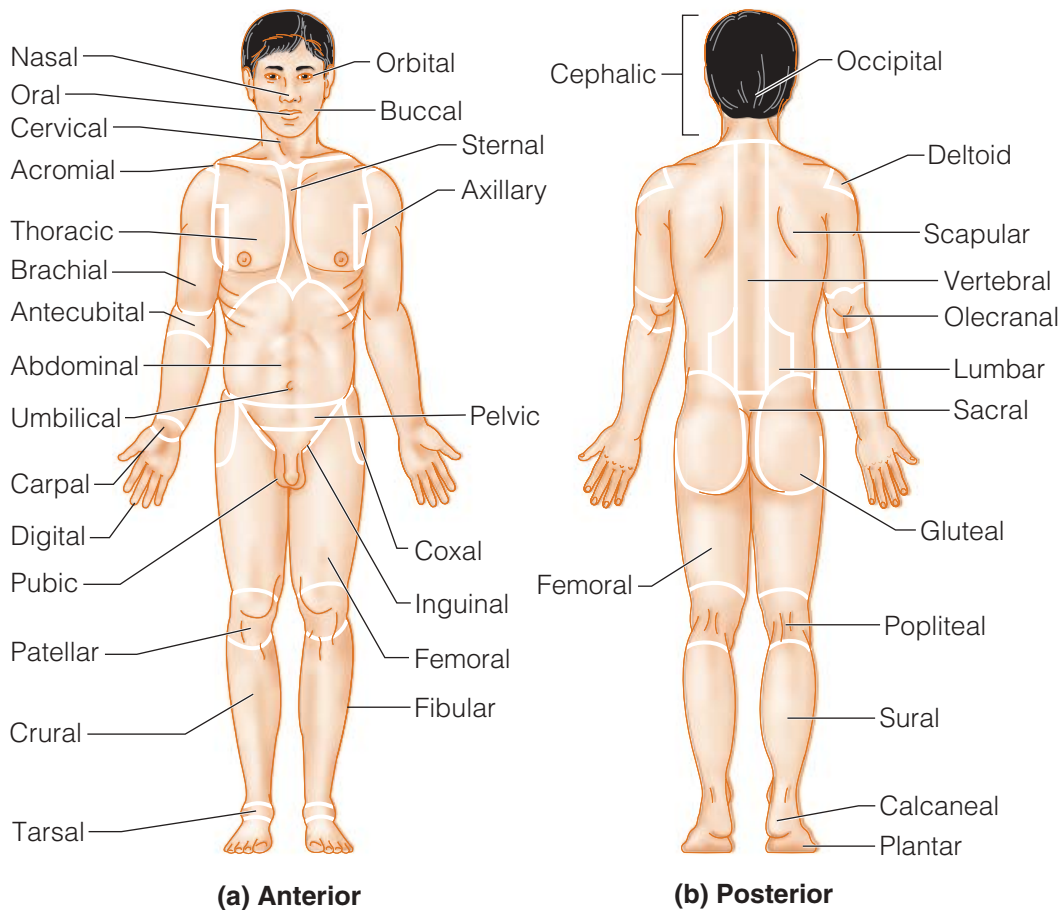
## The Language of Anatomy

Learning about the body is exciting, but our interest sometimes dwindles when we are confronted with the terminology of anatomy and physiology. Let's face it. You can't just pick up an anatomy and physiology book and read it as though it were a novel. Unfortunately, confusion is inevitable without specialized terminology. For example, if you are looking at a ball, “above” always means the area over the top of the ball. Other directional terms can also be used consistently because the ball is a sphere. All sides and surfaces are equal. The human body, of course, has many protrusions and bends. Thus, the question becomes: Above what? To prevent misunderstanding, anatomists have accepted a set of terms that allow body structures to be located and identified clearly with just a few words. This language of anatomy is presented and explained next.

## Anatomical Position

To accurately describe body parts and position, we must have an initial reference point and use directional terms. To avoid confusion, it is always assumed that the body is in a standard position called the **anatomical position**. It is important to understand this position because most body terminology used in this book refers to this body positioning *regardless* of the position the body happens to be in. The face-front diagrams in Figure 1.5 and Table 1.1 illustrate the anatomical position. As you can see, the body is erect with the feet parallel and the arms hanging at the sides with the palms facing forward.

**Q** Study this figure for a moment to answer these two questions. Where would you hurt if you (1) pulled a groin muscle or (2) cracked a bone in your olecranal area?



**FIGURE 1.5 Surface anatomy: Regional terms. (a)** Anterior body landmarks. **(b)** Posterior body landmarks. The heels are raised slightly to show the inferior plantar surface (sole) of the foot

- Stand up and assume the anatomical position. Notice that it is similar to “standing at attention” but is less comfortable because the palms are held unnaturally forward with thumbs pointing away from the body rather than hanging cupped toward the thighs.

## Regional Terms

There are many visible landmarks on the surface of the body. Once you know their proper anatomical names, you can be specific in referring to different regions of the body.

### Anterior Body Landmarks

Look at Figure 1.5a to find the following body regions. Once you have identified all the anterior body landmarks, cover the labels that describe what the structures are, and again go through the list, pointing out these areas on your own body.

**A**

(1) Your inguinal area. (2) Your posterior elbow region.

- **abdominal** (ab-dom'ī-nal): anterior body trunk inferior to ribs
- **acromial** (ah-kro'me-ul): point of shoulder
- **antecubital** (an'te-ku'bī-tal): anterior surface of elbow
- **axillary** (ak'sī-lar'e): armpit
- **brachial** (bra'ke-al): arm
- **buccal** (buk'al): cheek area
- **carpal** (kar'pal): wrist
- **cervical** (ser'vī-kal): neck region
- **coxal** (kox'al): hip
- **crural** (kroo'ral): leg
- **digital** (dij'ī-tal): fingers, toes
- **femoral** (fem'or-al): thigh
- **fibular** (fib'u-lar): lateral part of leg
- **inguinal** (in'gwī-nal): area where thigh meets body trunk; groin
- **nasal** (na'zul): nose area
- **oral** (o'ral): mouth
- **orbital** (or'bī-tal): eye area
- **patellar** (pah-tel'er): anterior knee
- **pelvic** (pel'vik): area overlying the pelvis anteriorly
- **pubic** (pu'bik): genital region
- **sternal** (ster'nul): breastbone area
- **tarsal** (tar'sal): ankle region
- **thoracic** (tho-ras'ik): chest
- **umbilical** (um-bil'ī-kal): navel

### Posterior Body Landmarks

Identify the following body regions in Figure 1.5b, and then locate them on yourself without referring to this book.

- **calcaneal** (kal-ka'neul): heel of foot
- **cephalic** (seh-fā'lik): head
- **deltoid** (del'toyd): curve of shoulder formed by large deltoid muscle
- **femoral** (fem'or-al): thigh
- **gluteal** (gloo'te-al): buttock
- **lumbar** (lum'bar): area of back between ribs and hips
- **occipital** (ok-sip'ī-tal): posterior surface of head
- **olecranal** (ol-eh-cra'nel): posterior surface of elbow
- **popliteal** (pop-lit'e-al): posterior knee area
- **sacral** (sa'krul): area between hips
- **scapular** (skap'u-lar): shoulder blade region
- **sural** (soo'ral): the posterior surface of lower leg; the calf
- **vertebral** (ver'tē-bral): area of spine

The **plantar** region, or the sole of the foot, actually on the inferior body surface, is illustrated along with the posterior body landmarks in Figure 1.5b.

### Directional Terms

**Directional terms** used by medical personnel and anatomists allow them to explain exactly where one body structure is in relation to another. For example, we can describe the relationship between the ears and the nose informally by saying, “The ears are located on each side of the head to the right and left of the nose.” Using anatomical terminology, this condenses to, “The ears are lateral to the nose.” Thus, using anatomical terminology saves a good deal of description and, once learned, is much clearer. Commonly used directional terms are defined and illustrated in Table 1.1. Although most of these terms are also used in everyday conversation, keep in mind that their anatomical meanings are very precise.

Before continuing, take a minute to check your understanding of what you have read in Table 1.1. Give the relationship between the following body parts using the correct anatomical terms.

The wrist is \_\_\_\_\_ to the hand.

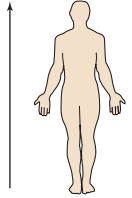
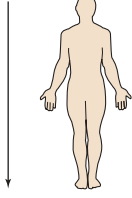


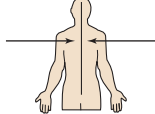
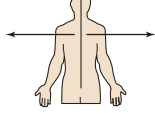
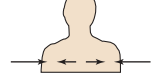
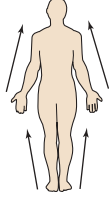
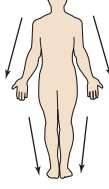
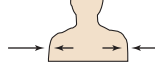

The breastbone is \_\_\_\_\_ to the spine.

The brain is \_\_\_\_\_ to the spinal cord.

The lungs are \_\_\_\_\_ to the stomach.

The thumb is \_\_\_\_\_ to the fingers. (Be careful here. Remember the anatomical position.)

**TABLE 1.1** Orientation and Directional Terms

Term	Definition	Illustration	Example
Superior (cranial or cephalad)	Toward the head end or upper part of a structure or the body; above		The forehead is superior to the nose.
Inferior (caudal) <sup>†</sup>	Away from the head end or toward the lower part of a structure or the body; below		The navel is inferior to the breastbone.
Anterior (ventral)*	Toward or at the front of the body; in front of		The breastbone is anterior to the spine.
Posterior (dorsal)*	Toward or at the backside of the body; behind		The heart is posterior to the breastbone.
Medial	Toward or at the midline of the body; on the inner side of		The heart is medial to the arm.
Lateral	Away from the midline of the body; on the outer side of		The arms are lateral to the chest.
Intermediate	Between a more medial and a more lateral structure		The armpit is intermediate between the breastbone and shoulder.
Proximal	Close to the origin of the body part or the point of attachment of a limb to the body trunk		The elbow is proximal to the wrist (meaning that the elbow is closer to the shoulder or attachment point of the arm than the wrist is).
Distal	Farther from the origin of a body part or the point of attachment of a limb to the body trunk		The knee is distal to the thigh.
Superficial (external)	Toward or at the body surface		The skin is superficial to the skeleton.
Deep (internal)	Away from the body surface; more internal		The lungs are deep to the rib cage.

<sup>†</sup>The term *caudal*, literally "toward the tail," is synonymous with *inferior* only to the inferior end of the spine.

\**Ventral* and *anterior* are synonymous in humans; this is not the case in four-legged animals. *Ventral* refers to the "belly" of an animal and thus is the inferior surface of four-legged animals. Likewise, although the dorsal and posterior surfaces are the same in humans, the term *dorsal* refers to an animal's back. Thus, the dorsal surface of four-legged animals is their superior surface.