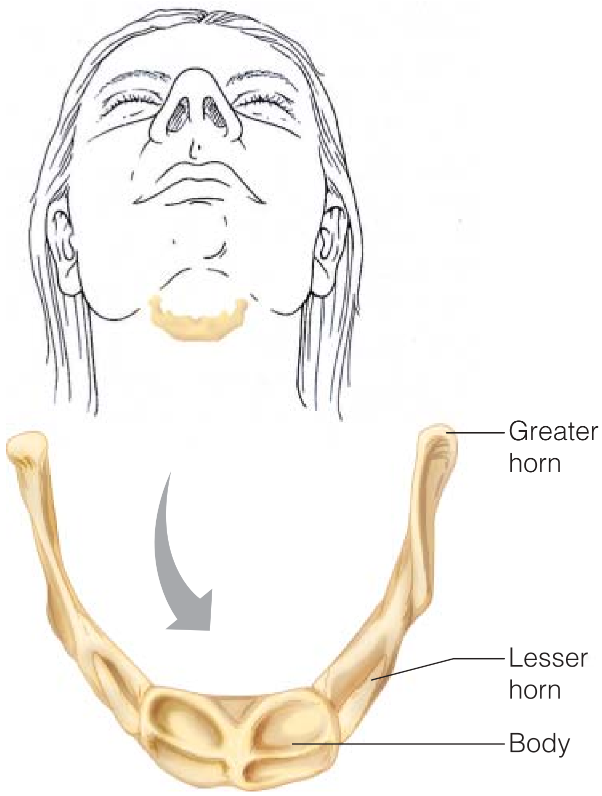

FIGURE 5.12 Anatomical location and structure of the hyoid bone. The hyoid bone is suspended in the midanterior neck by ligaments attached to the lesser horns and the styloid processes of the temporal bones.

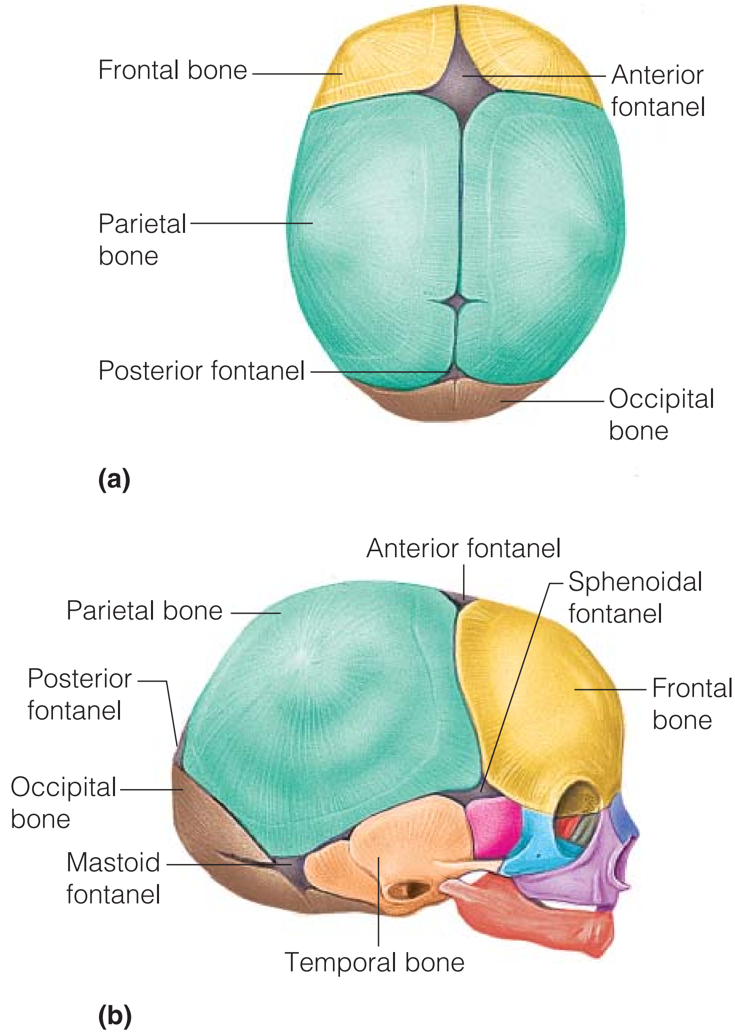

FIGURE 5.13 The fetal skull. (a) Superior view. **(b)** Lateral view.

is one-fourth as long as its entire body. When a baby is born, its skeleton is still unfinished. As noted earlier, some areas of hyaline cartilage still remain to be ossified, or converted to bone. In the newborn, the skull also has fibrous regions that have yet to be converted to bone. These fibrous membranes connecting the cranial bones are called **fontanels** (fon″tah-nelz′). The rhythm of the baby's pulse can be felt in these "soft spots," which explains their name (*fontanel* = little fountain). The largest fontanels are the diamond-shaped *anterior fontanel* and the smaller triangular *posterior fontanel.* The fontanels allow the fetal skull to be compressed slightly during birth. In addition, because they are flexible, they allow the infant's brain to grow during the later part of pregnancy and early infancy. This would not be possible if the cranial bones were fused in sutures as in the adult skull. The fontanels are gradually converted to bone during the early part of infancy and can no longer be felt by 22 to 24 months after birth.

Vertebral Column (Spine)

Serving as the axial support of the body, the **vertebral column,** or **spine,** extends from the skull, which it supports, to the pelvis, where it transmits the weight of the body to the lower limbs. Some people think of the vertebral column as a rigid supporting rod, but that picture is inaccurate. Instead, the spine is formed from 26 irregular bones connected and reinforced by ligaments in such a way that a flexible, curved structure results

Protect Your Back—It's the Only One You've Got! *(continued)*

(b) *Stretching the flexor muscles of the hip.* Lie on back. Exhale as you bring both knees toward the chest. Then, while holding one knee to the chest, slide the opposite leg along the floor until it is fully extended. Attempt to touch the back of the knee (popliteal region) of the extended leg to the floor. Hold for a count of 6.

Resume the starting position and repeat the exercise with the alternate leg. Repeat the entire exercise 5 to 6 times.

(c) *Strengthening the abdominal muscles.* Lie on back with knees bent and feet flat on floor. Keeping your arms at your sides, raise one knee toward your chest. Exhale as you lift your head, attempting to touch your raised knee to your forehead. Count to 6. Resume the starting position and roll your head gently from side to side. Inhale, and repeat the exercise with the alternate leg.

Repeat the entire exercise 8 to 10 times at the beginning; work up to 25 repetitions per day.

(b)

(c)

(Figure 5.14). Running through the central cavity of the vertebral column is the delicate spinal cord, which it surrounds and protects.

Before birth, the spine consists of 33 separate bones called **vertebrae,** but 9 of these eventually fuse to form the two composite bones, the *sacrum* and the *coccyx,* that construct the inferior portion of the vertebral column. Of the 24 single bones, the 7 vertebrae of the neck are *cervical vertebrae,* the next 12 are the *thoracic vertebrae,* and the remaining 5 supporting the lower back are *lumbar vertebrae.*

- Remembering common meal times, 7 AM, 12 noon, and 5 PM, may help you to recall the number of bones in these three regions of the vertebral column.

The single vertebrae are separated by pads of flexible fibrocartilage—**intervertebral discs**—which cushion the vertebrae and absorb shocks while allowing the spine flexibility. In a young person, the discs have a high water content (about 90 percent) and are spongy and compressible. But as a person ages, the water content of the discs decreases (as it does in other tissues throughout the body), and the discs become harder and less compressible.

Homeostatic Imbalance

Drying of the discs, along with a weakening of the ligaments of the vertebral column, predisposes older people to *herniated* ("slipped") *discs.* However, herniation also may result when the vertebral column is subjected to exceptional twisting forces. If the protruding disc presses on the spinal cord or the spinal nerves exiting from the cord, numbness and excruciating pain can result. ▲

The discs and the S-shaped structure of the vertebral column work together to prevent shock to the head when we walk or run. They also make the body trunk flexible. The spinal curvatures in the thoracic and sacral regions are referred to as **primary curvatures** because they are present when we are born. Later, the **secondary curvatures** develop. The cervical curvature appears when a baby begins to raise its head, and the lumbar curvature develops when the baby begins to walk.

Homeostatic Imbalance

Why do they do "spine checks" in middle school? The answer is that they are looking for abnormal spinal curvatures. There are several types of abnormal spinal curvatures. Figure 5.15 shows three of these—*scoliosis* (sko″le-o′sis), *kyphosis* (ki-fo′sis), and *lordosis* (lor-do′sis). These abnormalities may be congenital (present at birth) or result from disease, poor posture, or unequal muscle pull on the spine. As you look at these diagrams, try to pinpoint how each of these conditions differs from the normal healthy spine. ▲

Q *What is a slipped disc?*

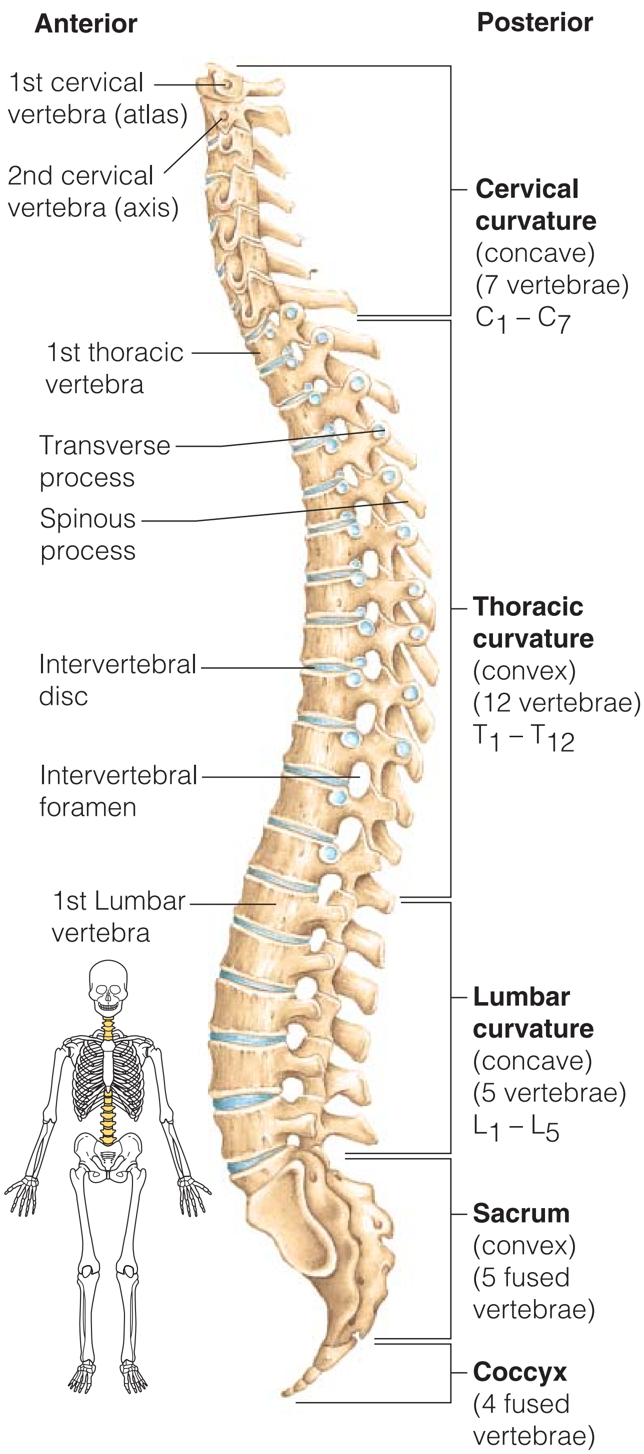

FIGURE 5.14 **The vertebral column.** Thin discs between the thoracic vertebrae allow great flexibility in the thoracic region; thick discs between the lumbar vertebrae reduce flexibility. Notice that the terms *convex* and *concave* refer to the curvature of the posterior aspect of the vertebral column.

A *A disc that protrudes outward from its normal position in the vertebral column and which may cause pain by pressing on adjacent nerves.*

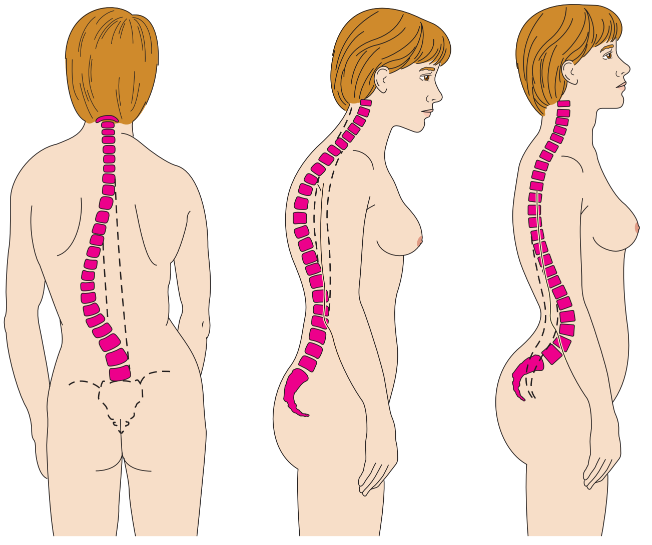

FIGURE 5.15 **Abnormal spinal curvatures.**

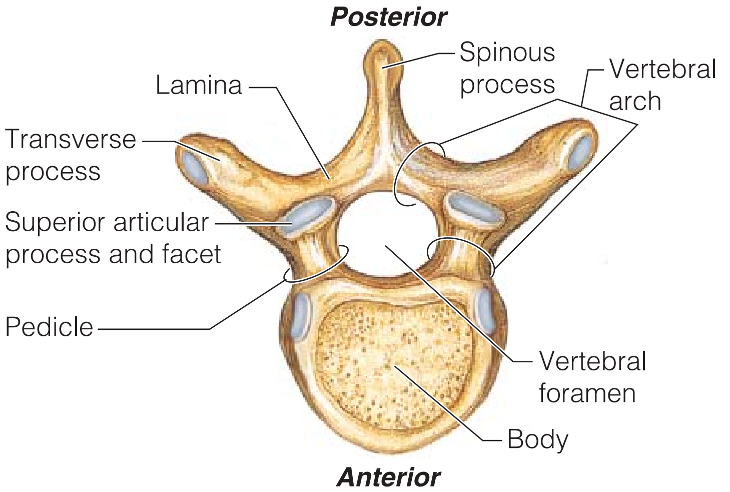

FIGURE 5.16 **A typical vertebra, superior view.** (Inferior articulating surfaces are not shown.)

All vertebrae have a similar structural pattern (Figure 5.16). The common features are listed below:

- **Body** or **centrum:** disclike, weight-bearing part of the vertebra facing anteriorly in the vertebral column.
- **Vertebral arch:** arch formed from the joining of all posterior extensions, the **laminae** and **pedicles,** from the vertebral body.
- **Vertebral foramen:** canal through which the spinal cord passes.
- **Transverse processes:** two lateral projections from the vertebral arch.
- **Spinous process:** single projection arising from the posterior aspect of the vertebral arch (actually the fused laminae).
- **Superior and inferior articular processes:** paired projections lateral to the vertebral foramen, allowing a vertebra to form joints with adjacent vertebrae (see also Figure 5.17).

In addition to the common features just described, vertebrae in the different regions of the spine have very specific structural characteristics. These unique regional characteristics of the vertebrae are described next.

Cervical Vertebrae

The seven **cervical vertebrae** (identified as C_1 to C_7) form the neck region of the spine. The first two vertebrae (*atlas* and *axis*) are different because they perform functions not shared by the other cervical vertebrae. As you can see in Figure 5.17a, the **atlas** (C_1) has no body. The superior surfaces of its transverse processes contain large depressions that receive the occipital condyles of the skull. This joint allows you to nod "yes." The **axis** (C_2) acts as a pivot for the rotation of the atlas (and skull) above. It has a large upright process, the **dens,** or **odontoid** (o-don′toid) **process,** which acts as the pivot point. The joint between C_1 and C_2 allows you to rotate your head from side to side to indicate "no."

The "typical" cervical vertebrae (C_3 through C_7) are shown in Figure 5.17b. They are the smallest, lightest vertebrae, and most often their spinous processes are short and divided into two branches. The transverse processes of the cervical vertebrae contain foramina (openings) through which the vertebral arteries pass on their way to the brain above. Any time you see these foramina in a vertebra, you should know immediately that it is a cervical vertebra.

Thoracic Vertebrae

The 12 **thoracic vertebrae** (T_1 to T_{12}) are all typical. As seen in Figure 5.17c, they are larger than the cervical vertebrae. The body is somewhat heart-shaped and has two costal facets (articulating surfaces) on each side, which receive the heads of the ribs. The spinous process is long and hooks sharply downward, causing the vertebra to look like a giraffe's head viewed from the side.

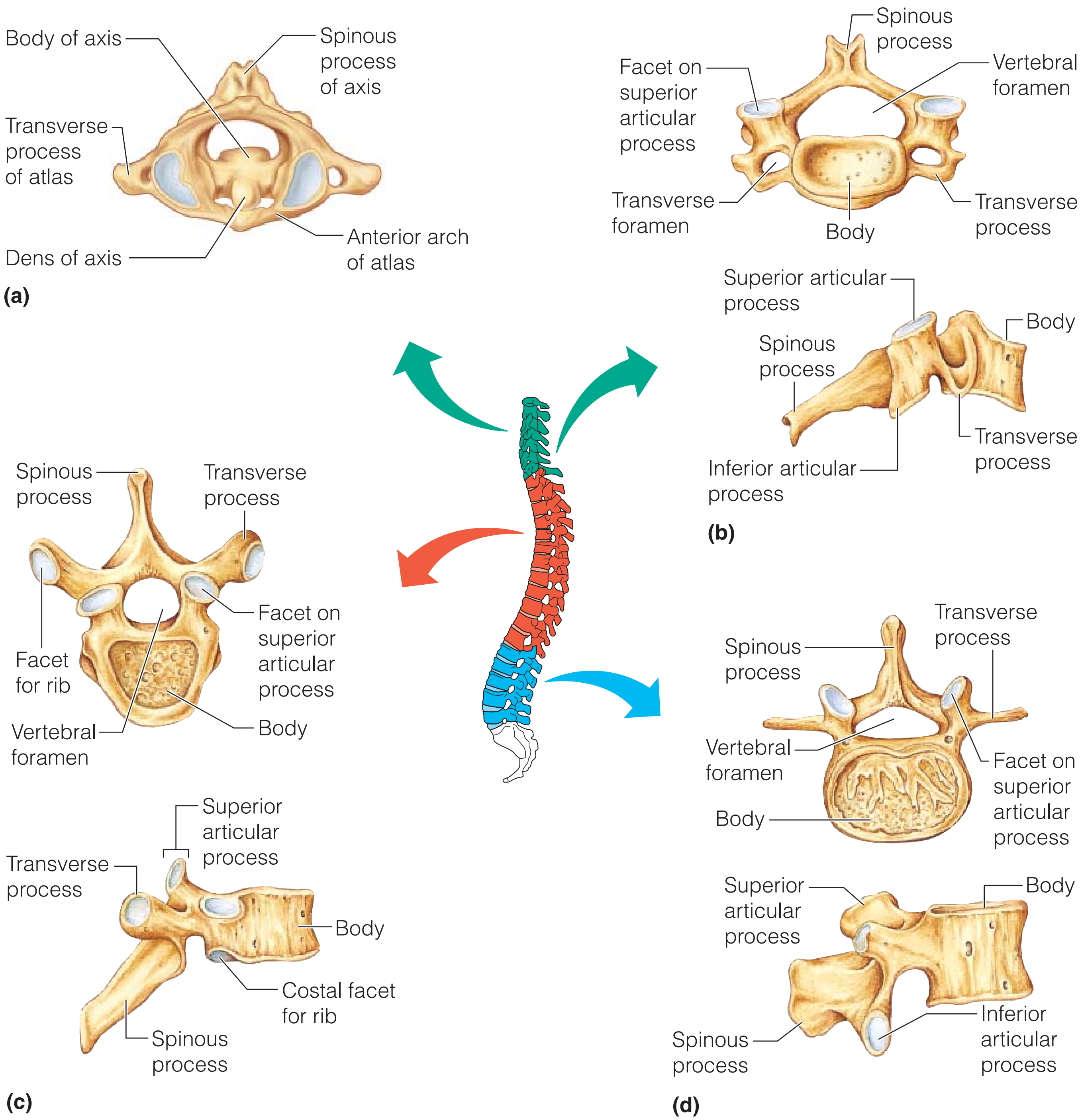

FIGURE 5.17 Regional characteristics of vertebrae. (a) Superior view of the articulated atlas and axis. **(b)** Cervical vertebrae; superior view above, lateral view below. **(c)** Thoracic vertebrae; superior view above, lateral view below. **(d)** Lumbar vertebrae; superior view above, lateral view below.

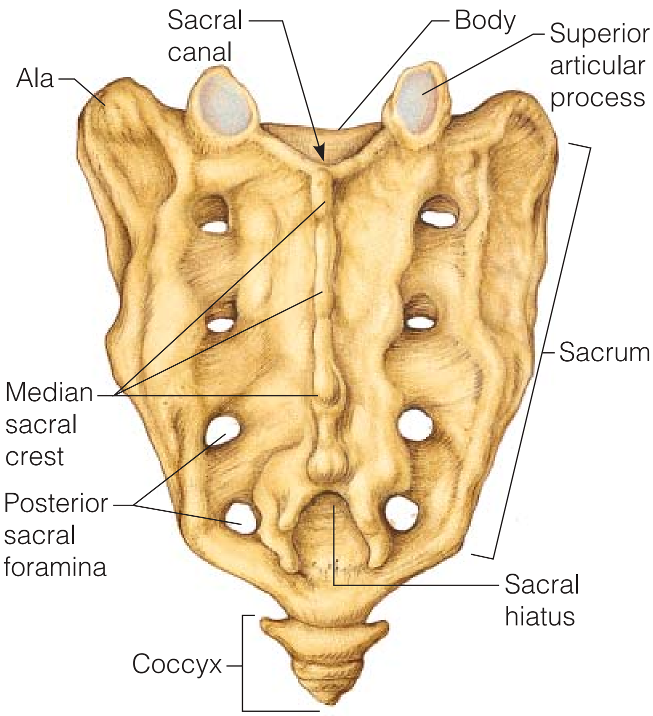

FIGURE 5.18 **Sacrum and coccyx, posterior view.**

Lumbar Vertebrae

The five **lumbar vertebrae** (L_1 to L_5) have massive, blocklike bodies. Their short, hatchet-shaped spinous processes (Figure 5.17d) make them look like a moose head from the lateral aspect. Since most of the stress on the vertebral column occurs in the lumbar region, these are the sturdiest of the vertebrae.

Sacrum

The **sacrum** (sa′krum) is formed by the fusion of five vertebrae (Figure 5.18). Superiorly it articulates with L_5, and inferiorly it connects with the coccyx. The winglike **alae** articulate laterally with the hip bones, forming the sacroiliac joints. The sacrum forms the posterior wall of the pelvis. Its posterior midline surface is roughened by the **median sacral crest,** the fused spinous processes of the sacral vertebrae. This is flanked laterally by the posterior sacral foramina. The vertebral canal continues inside the sacrum as the **sacral canal** and terminates in a large inferior opening called the **sacral hiatus.**

Coccyx

The **coccyx** is formed from the fusion of three to five tiny, irregularly shaped vertebrae (Figure 5.18). It is the human "tailbone," a remnant of the tail that other vertebrate animals have.

Bony Thorax

The sternum, ribs, and thoracic vertebrae make up the **bony thorax.** The bony thorax is often called the **thoracic cage** because it forms a protective, cone-shaped cage of slender bones around the organs of the thoracic cavity (heart, lungs, and major blood vessels). The bony thorax is shown in Figure 5.19.

Sternum

The **sternum** (breastbone) is a typical flat bone and the result of the fusion of three bones—the **manubrium** (mah-nu′bre-um), **body,** and **xiphoid** (zif′oid) **process.** It is attached to the first seven pairs of ribs.

The sternum has three important bony landmarks—the jugular notch, the sternal angle, and the xiphisternal joint.

- The **jugular notch** (concave upper border of the manubrium) can be palpated easily; generally it is at the level of the third thoracic vertebra.
- The **sternal angle** results where the manubrium and body meet at a slight angle to each other, so that a transverse ridge is formed at the level of the second ribs. It provides a handy reference point for counting ribs to locate the second intercostal space for listening to certain heart valves.
- The **xiphisternal** (zi′fe-ster″nal) **joint,** the point where the sternal body and xiphoid process fuse, lies at the level of the ninth thoracic vertebra.

Palpate your sternal angle and jugular notch.

Because the sternum is so close to the body surface, it is easy to obtain samples of blood-forming (hematopoietic) tissue for the diagnosis of suspected blood diseases from this bone. A needle is inserted into the marrow of the sternum, and the sample is withdrawn; this procedure is called a *sternal puncture*. Because the heart lies immediately posterior to the sternum, the physician must take extreme care not to penetrate through the sternum during this procedure.

Ribs

Twelve pairs of **ribs** form the walls of the bony thorax. (Contrary to popular misconception, males do *not* have one rib less than females!) All the ribs

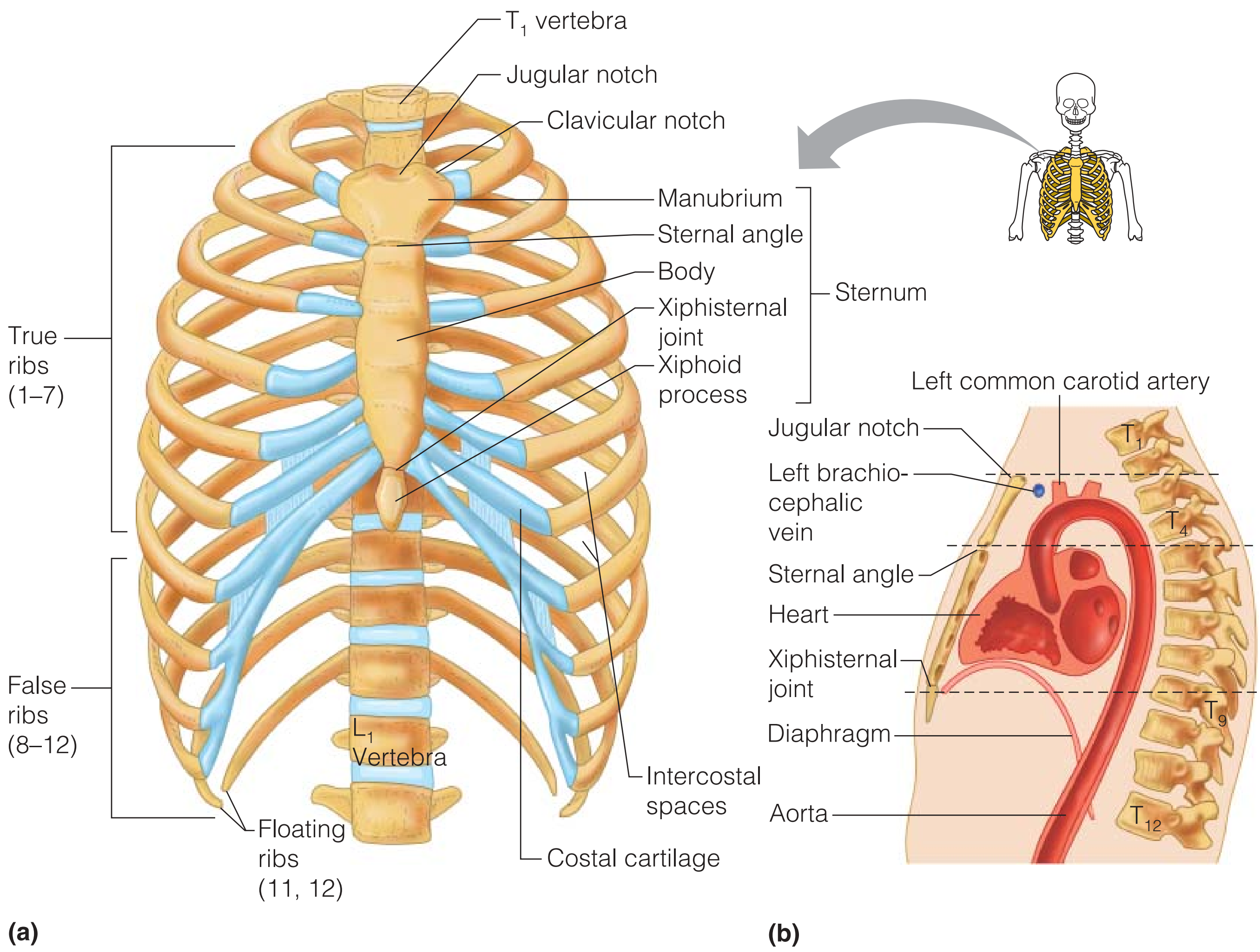

FIGURE 5.19 The bony thorax. (a) Skeleton of the bony thorax, anterior view (costal cartilages are shown in blue). **(b)** Left lateral view of the thorax, showing the relationship of the surface landmarks of the thorax to the vertebral column (thoracic portion).

articulate with the vertebral column posteriorly and then curve downward and toward the anterior body surface. The **true ribs,** the first seven pairs, attach directly to the sternum by costal cartilages. **False ribs,** the next five pairs, either attach indirectly to the sternum or are not attached to the sternum at all. The last two pairs of false ribs lack the sternal attachments, and so they are also called **floating ribs.**

The intercostal spaces (spaces between the ribs) are filled with the intercostal muscles that aid in breathing.

Appendicular Skeleton

The *appendicular skeleton* is shaded gold in Figure 5.6. It is composed of 126 bones of the limbs (appendages) and the pectoral and pelvic girdles, which attach the limbs to the axial skeleton.

Bones of the Shoulder Girdle

Each **shoulder girdle,** or **pectoral girdle,** consists of two bones—a clavicle and a scapula (Figure 5.20).

The **clavicle** (klav′ĭ-kl), or *collarbone,* is a slender, doubly curved bone. It attaches to the manubrium of the sternum medially (at its sternal end) and to the scapula laterally, where it helps to form the shoulder joint (at its acromial end). The clavicle acts as a brace to hold the arm away from the top of the thorax and helps prevent shoulder dislocation. When the clavicle is broken, the whole shoulder region caves in medially, which shows how important its bracing function is.