JOINTS (ARTICULATIONS)

Every bone in the body, except one, connects to at least one other bone. In other words, every bone but one forms a joint with some other bone. (The exception is the hyoid bone in the neck, to which the tongue anchors.) Most of us probably never think much about our joints unless something goes wrong with them and they do not function properly. Then their tremendous importance becomes painfully clear. Joints hold our bones together securely and at the same time make it possible for movement to occur between the bones—between most of them, that is. Without joints we could not move our arms, legs, or many other of our body parts. Our bodies would, in short, be rigid, immobile hulks. Try, for example, to move your arm at your shoulder joint in as many directions as you can. Try to do the same thing at your elbow joint. Now examine the shape of the bones at each of these joints on a skeleton or in Figure 5-7. Do you see why you cannot move your arm at your elbow in nearly as many directions as you can at your shoulder?

Kinds of Joints

One method classifies joints into three types according to the degree of movement they allow:

1. Synarthroses (no movement)
2. Amphiarthroses (slight movement)
3. Diarthroses (free movement)

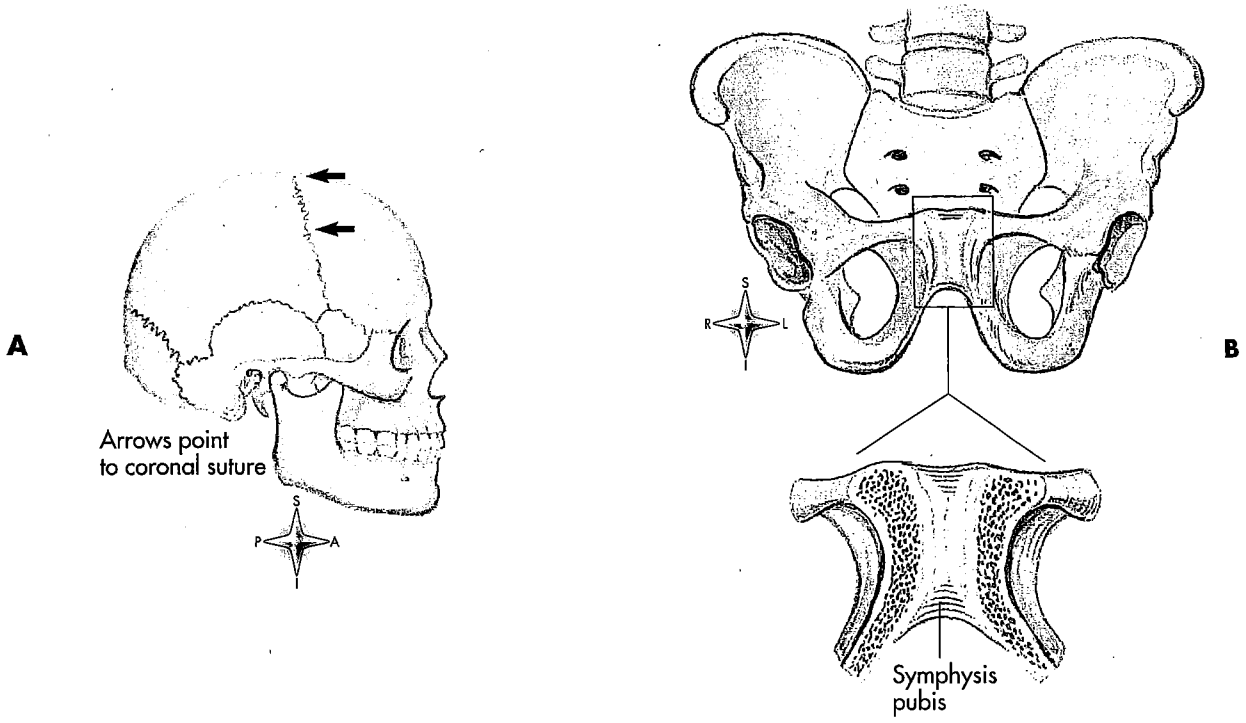
Differences in joint structure account for differences in the degree of movement that is possible.

SYNARTHROSES

A synarthrosis is a joint in which fibrous connective tissue grows between the articulating (joining) bones holding them close together. The joints between cranial bones are synarthroses, commonly called *sutures* (Figure 5-19, *A*).

FIGURE 5-19

Joints of the skeleton. A, Synarthrotic joint. **B,** Amphiarthrotic joint.



Amphiarthroses

An amphiarthrosis is a joint in which cartilage connects the articulating bones. The symphysis pubis, the joint between the two pubic bones, is an amphiarthrosis (Figure 5-19, *B*).

Joints between the bodies of the vertebrae are also amphiarthroses. These joints make it possible to flex the trunk forward or sideways and even to circumduct and rotate it. Strong ligaments connect the bodies of the vertebrae, and fibrous disks lie between them. The central core of these intervertebral disks consists of a pulpy, elastic substance that loses some of its resiliency with age.

Diarthroses

Fortunately most of our joints by far are diarthroses. Such joints allow considerable movement, sometimes in many directions and sometimes in only one or two directions.

Structure. Diarthroses (freely movable joints) are made alike in certain ways. All have a joint capsule, a joint cavity, and a layer of cartilage over the ends of two joining bones (Figure 5-20). The **joint capsule** is made of the body's strongest and toughest material, fibrous connective tissue, and is lined with a smooth, slippery synovial membrane. The capsule fits over the ends of the two bones somewhat like a sleeve. Because it attaches firmly to the shaft of each bone to form its covering (called the *periosteum; peri* means "around," and *osteum* means "bone"), the joint capsule holds the bones securely together but at the same time permits movement at the joint. The structure of the joint capsule, in other words, helps make possible the joint's function.

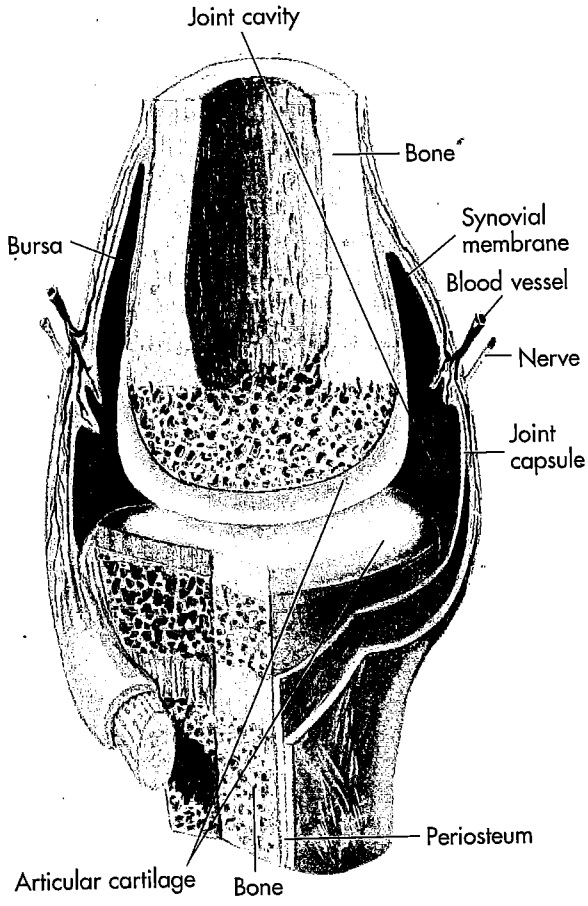
Ligaments (cords or bands made of the same strong fibrous connective tissue as the joint capsule) also grow out of the periosteum and lash the two bones together even more firmly.

The layer of **articular cartilage** over the joint ends of bones acts like a rubber heel on a shoe—it absorbs jolts. The articular cartilage also provides a smooth surface so the bones of the joint can move with little friction. The **synovial membrane** secretes a lubricating fluid (synovial fluid) that allows easier movement with less friction.

There are several types of diarthroses: ball-and-socket, hinge, pivot, saddle, gliding, and condyloid (Figure 5-21). Because they differ in structure, they differ also in their possible range of movement. In a ball-and-socket joint, a ball-shaped head of one bone fits into a concave socket of another bone. Shoulder and hip joints, for example, are ball-and-socket joints. Of all the joints in our bodies, these permit the widest range of movements. Think for a moment about how many ways you can move your upper arms. You can move them forward, you can move them backward, you can move them away from the sides of your body, and you can move them back down to

FIGURE 5-20

Structure of a diarthrotic joint. Each diarthrosis has a joint capsule, a joint cavity, and a layer of cartilage over the ends of the joined bones.



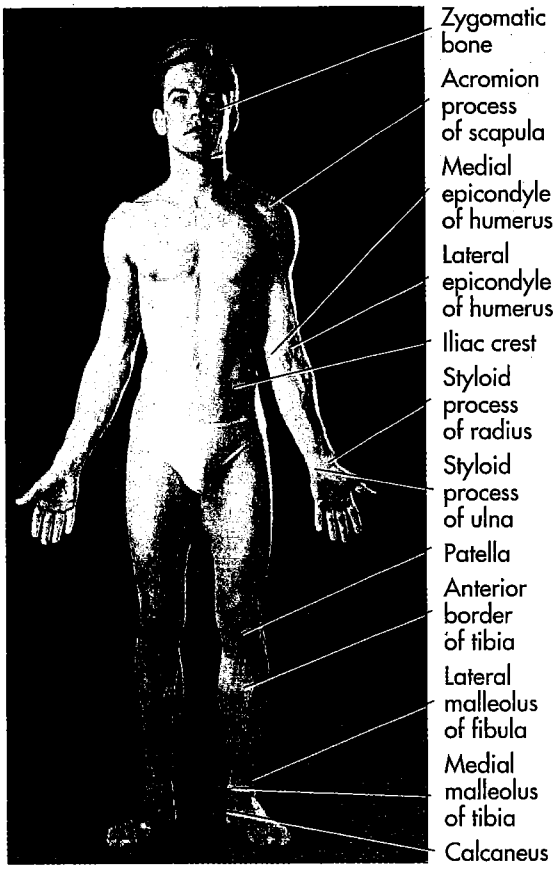
CLINICAL APPLICATION

Palpable Bony Landmarks

Health professionals often identify externally palpable bony landmarks when dealing with the sick and injured. **Palpable** bony landmarks are bones that can be touched and identified through the skin. They serve as reference points in identifying other body structures.

There are externally palpable bony landmarks throughout the body. Many skull bones such as the zygomatic bone can be palpated. The medial and lateral epicondyles of the humerus, the olecranon process of the ulna, and the styloid process of the ulna and the radius at the wrist can be palpated on the upper extremity. The highest corner of the shoulder is the acromion process of the scapula.

When you put your hands on your hips, you can feel the superior edge of the ilium called the *iliac crest*. The anterior end of the crest, called the *anterior superior iliac spine*, is a prominent landmark used often as a clinical reference. The medial malleolus of the tibia and the lateral malleolus of the fibula are prominent at the ankle. The calcaneus or heel bone is easily palpated on the posterior aspect of the foot. On the anterior aspect of the lower extremity, examples of palpable bony landmarks include the patella or knee cap, the anterior border of the tibia or shin bone, and the metatarsals and phalanges of the toes. Try to identify as many of the externally palpable bones of the skeleton as possible on your own body. Using these as points of reference will make it easier for you to visualize the placement of other bones that cannot be touched or palpated through the skin.



your sides. You can also move them around so as to describe a circle with your hands.

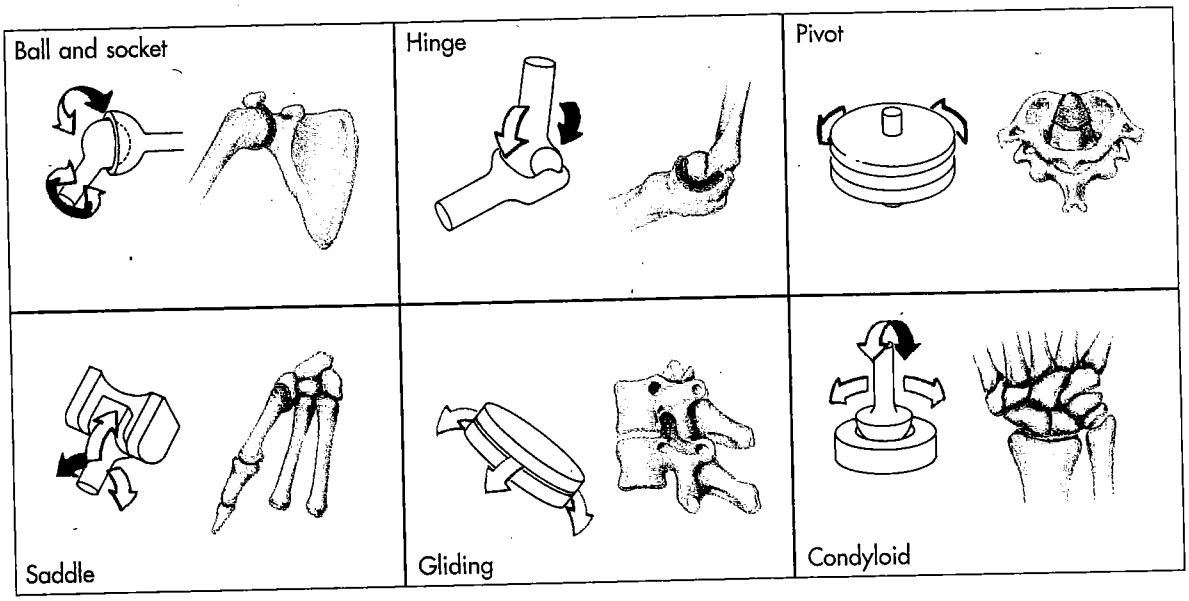
Hinge joints, like the hinges on a door, allow movements in only two directions, namely, flexion and extension. **Flexion** is bending a joint; **extension** is straightening it out (Table 5-7). Elbow and knee joints and the joints in the fingers are hinge joints.

Pivot joints are those in which a small projection of one bone pivots in an arch of another bone. For example, a projection of the axis, the second vertebra in the neck, pivots in an arch of the atlas, the first vertebra in the neck. This **rotates** the head, which rests on the atlas.

Only one pair of saddle joints exists in the body—between the metacarpal bone of each thumb and a carpal bone of the wrist (the name of this carpal bone is the *trapezium*). Because the articulating surfaces of these bones are saddle-shaped, they make possible the human thumb's great mobility, a mobility no animal's thumb possesses. We can **flex, extend, abduct, adduct,** and **circumduct** our thumbs, and most important of all, we can move our thumbs to touch the tip of any one of

FIGURE 5-21

Types of diarthrotic joints. Notice that the structure of each type dictates its function (movement).



CLINICAL APPLICATION

Total Hip Replacement

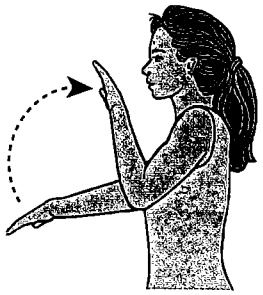
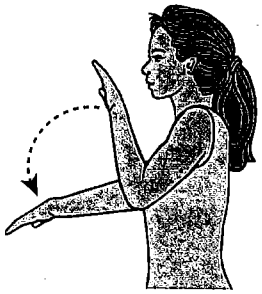
Because total hip replacement (THR) is the most common orthopedic operation performed on older persons (more than 200,000 procedures per year in the United States), home health care professionals often work with patients recovering from THR surgery.

The THR procedure involves replacement of the femoral head by a metal prosthesis and the acetabular socket by a polyethylene cup. The prostheses are usually coated with a porous material that allows natural growth of bone to mesh with the artificial material. Such meshing of tissue and prostheses ensures stability of the parts without the loosening that the use of glues in the past often allowed. First introduced in 1953, THR technique has advanced to the state that the procedure has a success rate of about 85%.

Patients at home after THR surgery should progress through proper surgical healing and recovery, including stabilization of the prostheses as new tissue grows into their porous surfaces. THR patients should also expect some improvement in regained use of the affected hip, including weight-bearing and walking movements.

TABLE 5-7

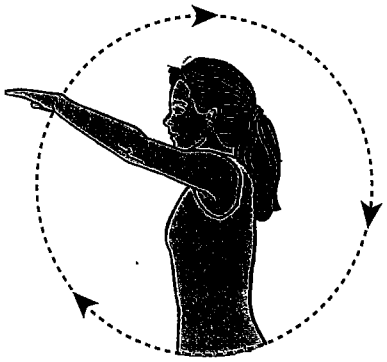
Types of Joint Movements

MOVEMENT	EXAMPLE	DESCRIPTION
Flexion (to flex a joint)		Reduces the angle of the joint, as in bending the elbow
Extension (to extend a joint)		Increases the angle of a joint, as in straightening a bent elbow
Rotation (to rotate a joint)		Spins one bone relative to another, as in rotating the head at the neck joint

Your study of these movements continues in Chapter 6, beginning on p. 133.

TABLE 5-7—CONT'D

Types of Joint Movements

MOVEMENT	EXAMPLE	DESCRIPTION
Circumduction (to circumduct a joint)		Moves the distal end of a bone in a circle, while keeping the proximal end relatively stable, as in moving the arm in a circle and thus circumducting the shoulder joint
Abduction (to abduct a joint)		Increases the angle of a joint to move a part away from the midline, as in moving the hand to the side and away from the body
Adduction (to adduct a joint)		Decreases the angle of a joint to move a part toward the midline, as in moving the hand in and down from the side

our fingers. (This movement is called *opposing the thumb to the fingers.*) Without the saddle joints at the base of each of our thumbs, we could not do such a simple act as picking up a pin or grasping a pencil between thumb and forefinger.

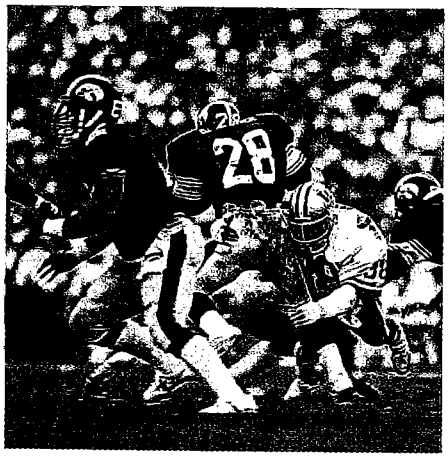
Gliding joints are the least movable diarthrotic joints. Their flat articulating surfaces allow limited gliding movements, such as that at the superior and inferior articulating processes between successive vertebrae.

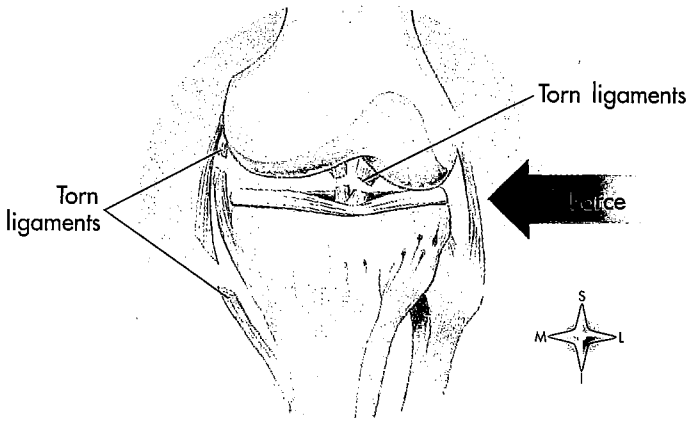
Condyloid joints are those in which a condyle (an oval projection) fits into an elliptical socket. An example is the fit of the distal end of the radius into depressions in the carpal bones.

HEALTH & WELL-BEING

The Knee Joint

The knee is the largest and most vulnerable joint. Because the knee is often subjected to sudden, strong forces during athletic activity, knee injuries are among the most common type of athletic injury. Sometimes, the articular cartilages on the tibia become torn when the knee twists while bearing weight. The ligaments holding the tibia and femur together can also be injured in this way. Knee injuries may also occur when a weight-bearing knee is hit by another person.





Outline Summary

FUNCTIONS OF BONE
A Supports and gives shape to the body
B Protects internal organs
C Helps make movements possible
D Stores calcium
E Hemopoiesis or blood cell formation

TYPES OF BONES
A Long—Example: humerus (upper arm)
B Short—Example: carpals (wrist)
C Flat—Example: frontal (skull)
D Irregular—Example: vertebrae (spinal cord)

STRUCTURE OF LONG BONES
A Structural components (Figure 5-1)
  1 Diaphysis or shaft
  2 Medullary cavity containing yellow marrow
  3 Epiphyses or ends of the bone; spongy bone contains red bone marrow
  4 Articular cartilage—covers epiphyses as a cushion
  5 Periosteum—strong membrane covering bone except at joint surfaces
  6 Endosteum—lines medullary cavity

MICROSCOPIC STRUCTURE OF BONE AND CARTILAGE
A Bone types (Figure 5-2)
  1 Spongy
    a Texture results from needlelike threads of bone called *trabeculae* surrounded by a network of open spaces
    b Found in epiphyses of bones
    c Spaces contain red bone marrow
  2 Compact
    a Structural unit is Haversian system—composed of concentric lamella, lacunae containing osteocytes, and canaliculi, all covered by periosteum
B Cartilage (Figure 5-4)
  1 Cell type called *chondrocyte*
  2 Matrix is gel-like and lacks blood vessels

BONE FORMATION AND GROWTH (Figures 5-5 and 5-6)
A Sequence of development early—cartilage models replaced by calcified bone matrix
B Osteoblasts form new bone, and osteoclasts resorb bone

DIVISIONS OF SKELETON
Skeleton composed of the following divisions and their subdivisions:
A Axial skeleton
  1 Skull
  2 Spine
  3 Thorax
  4 Hyoid bone
B Appendicular skeleton
  1 Upper extremities, including shoulder girdle
  2 Lower extremities, including hip girdle
C Location and description of bones—see Figures 5-7 to 5-17 and Tables 5-2 to 5-6

DIFFERENCES BETWEEN A MAN'S AND A WOMAN'S SKELETON
A Size—male skeleton generally larger
B Shape of pelvis—male pelvis deep and narrow, female pelvis broad and shallow
C Size of pelvic inlet—female pelvic inlet generally wider, normally large enough for baby's head to pass through it (Figure 5-18)
D Pubic angle—angle between pubic bones of female generally wider

JOINT (ARTICULATIONS)
A Kinds of joints (Figures 5-19 to 5-21)
  1 Synarthroses (no movement)—fibrous connective tissue grows between articulating bones; for example, sutures of skull
  2 Amphiarthroses (slight movement)—cartilage connects articulating bones; for example, symphysis pubis
  3 Diarthroses (free movement)—most joints belong to this class
    a Structures of freely movable joints—joint capsule and ligaments hold adjoining

Outline Summary—cont'd

bones together but permit movement at joint
- **b** Articular cartilage—covers joint ends of bones and absorbs joints
- **c** Synovial membrane—lines joint capsule and secretes lubricating fluid
- **d** Joint cavity—space between joint ends of bones

B Types of freely movable joints—ball-and-socket, hinge, pivot, saddle, gliding, and condyloid

New Words

amphiarthroses
appendicular skeleton
articular cartilage
articulation
axial skeleton
canaliculi
chondrocytes
compact bone
diaphysis
diarthroses
epiphyses
fontanels
hemopoiesis
lacunae
lamella
medullary cavity
osteoblasts
osteoclasts
osteocytes
osteon
pectoral girdle
pelvic girdle
periosteum
red bone marrow
sinus
skull
spine
synarthroses
synovial membrane
thorax
trabeculae
yellow bone marrow

Review Questions

1. List and briefly explain the five functions of the skeletal system.
2. Describe the structure of the osteon.
3. Describe the structure of cartilage.
4. Explain briefly the process on endochondral ossification. Include the function of the osteoblast and osteoclasts.
5. Explain the importance of the epiphyseal plate.
6. In general, what bones are included in the axial skeleton, the appendicular skeleton.
7. The vertebral column is divided into five sections based on location, name the sections and give the number of vertebrae in each section.
8. Distinguish between true, false, and floating ribs. How many of each are there?
9. Describe and give an example of a synarthritic joint.
10. Describe and give an example of an amphiarthritic joint.
11. Describe and give an example of two types of diarthritic joints.
12. Briefly describe a joint capsule.

Critical Thinking

13. When a patient receives a bone marrow transplant, what vital process is being restored?
14. Explain how the canaliculi allow bone to heal more efficiently than cartilage.
15. What effect does the task of childbearing have on the differences between the male and female skeleton?