EXERCISE 10

Joints and Body Movements

MATERIALS

- ❑ Articulated skeleton
- ❑ Skull
- ❑ Diarthrotic beef joint (fresh or preserved), preferably a knee joint sectioned sagittally
- ❑ Disposable gloves
- ❑ Water balloons and clamps
- ❑ Anatomical chart of joint types (if available)
- ❑ X-ray images of normal and arthritic joints (if available)

BEFORE YOU BEGIN

- Read the sections on joints and types of movements in your textbook.
- Scan the exercise for the objectives you will be expected to accomplish during this laboratory session.
- Brush up on cartilage tissue and skeletal articulations.

Nearly every bone in the body is connected to, or forms a joint with, at least one other bone. **Joints,** or **articulations,** perform two functions for the body. They (1) hold bones together and (2) allow the rigid skeleton some flexibility so that gross body movements can occur.

Joints may be classified by structure or by function. The *structural classification* is based on what separates the articulating bones—fibers, cartilage, or a joint cavity. Structurally, there are *fibrous, cartilaginous,* and *synovial joints.*

The functional classification focuses on the amount of movement the joint allows. On this basis, there are **synarthroses,** or immovable joints; **amphiarthroses,** or slightly movable joints; and **diarthroses,** or freely movable joints. Freely movable joints predominate in the limbs, whereas immovable and slightly movable joints are largely restricted to the axial skeleton.

The structural categories are more clear-cut, so we will use that classification here and indicate functional properties as appropriate. See Figure 10.1.

OBJECTIVE 1 Name the three structural categories of joints and compare their structure and mobility.

Fibrous Joints

In **fibrous joints,** the bones are joined by fibrous tissue. Some fibrous joints are slightly movable, but most are synarthrotic and permit virtually no movement.

The two major types of fibrous joints are sutures and syndesmoses. In **sutures** (Figure 10.1d) the irregular edges of the bones interlock and are united by very short connective tissue fibers, as in most joints of the skull. In **syndesmoses** the articulating bones are connected by short ligaments of dense fibrous tissue; the bones do not interlock. The joint at the distal end of the tibia and fibula is an example of a syndesmosis (Figure 10.1e). Although this syndesmosis allows some give, it is classified functionally as a synarthrosis.

ACTIVITY 1

Identifying Fibrous Joints

Examine a human skull again. Notice that adjacent bone surfaces do not actually touch but are separated by a wavy seam of ossified fibrous connective tissue. Also examine a skeleton and an anatomical chart of joint types for examples of fibrous joints.

Cartilaginous Joints

In **cartilaginous joints,** the articulating bone ends are connected by cartilage. Although there is variation, most cartilaginous joints are *slightly movable* (amphiarthrotis) functionally. An important type of cartilaginous joint is the symphysis. In a **symphysis** (*symphysis* means "a growth together") the bones are connected by a broad, flat disc of **fibrocartilage.** The intervertebral joints and the pubic symphysis of the pelvis are symphyses (see Figure 10.1b and c).

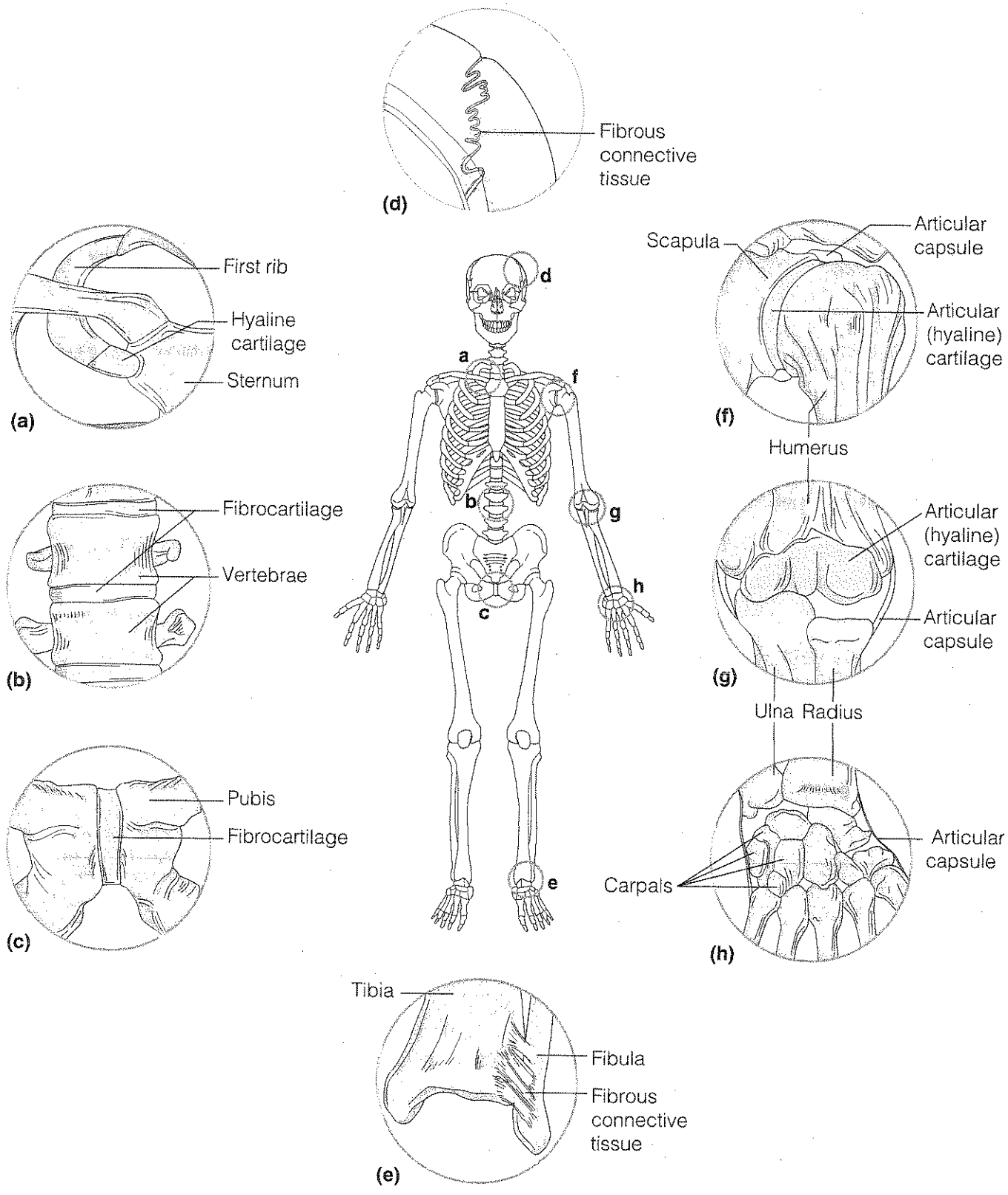


FIGURE 10.1 Types of joints. Joints to the left of the skeleton are cartilaginous joints; joints above and below the skeleton are fibrous joints; joints to the right of the skeleton are synovial joints. **(a)** Synchondrosis (joint between costal cartilage of rib 1 and the sternum). **(b)** Symphyses (intervertebral discs of fibrocartilage connecting adjacent vertebrae). **(c)** Symphysis (fibrocartilaginous pubic symphysis connecting the pubic bones anteriorly). **(d)** Suture (fibrous connective tissue connecting interlocking skull bones). **(e)** Syndesmosis (fibrous connective tissue connecting the distal ends of the tibia and fibula). **(f)** Synovial joint (multiaxial shoulder joint). **(g)** Synovial joint (uniaxial elbow joint). **(h)** Synovial joints (nonaxial (gliding) intercarpal joints of the hand).

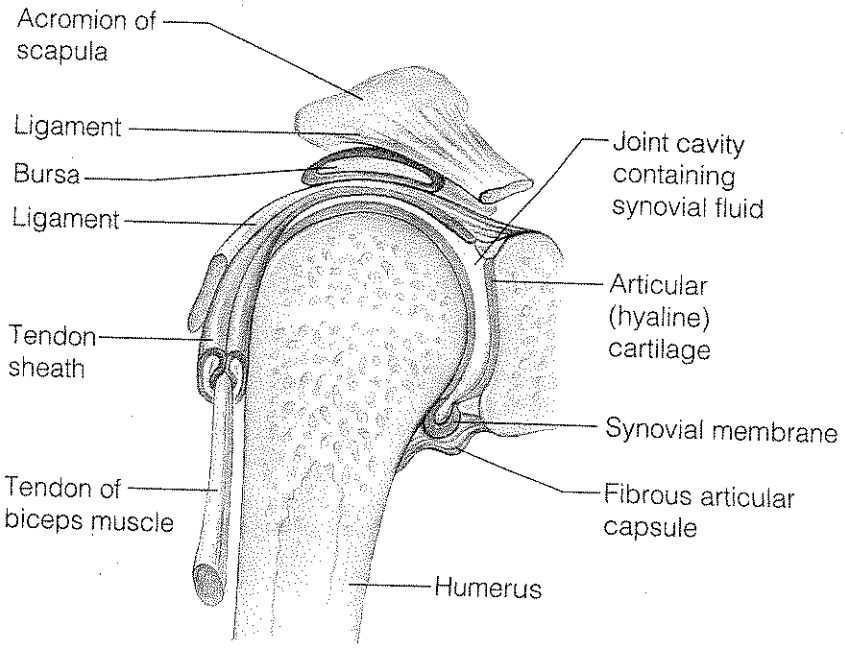


FIGURE 10.2 Major structural features of the shoulder joint, a synovial joint.

ACTIVITY 2

Identifying Cartilaginous Joints

Identify the cartilaginous joints on a human skeleton and on an anatomical chart of joint types.

Synovial Joints

In **synovial joints** the articulating bone ends are separated by a joint cavity containing synovial fluid (see Figure 10.1f–h). All synovial joints are diarthroses, or freely movable joints. Their mobility varies, however; some can move in only one plane, and others can move in several directions (multiaxial movement). Most joints in the body are synovial joints.

All synovial joints have the following structural characteristics (Figure 10.2):

- The joint surfaces are enclosed by a fibrous *articular capsule* creating a joint cavity.
- This capsule is lined inside with a smooth connective tissue membrane, called *synovial membrane*, which produces a lubricating fluid (synovial fluid) that reduces friction.
- Articulating surfaces of the bones forming the joint are covered with *articular* (hyaline) *cartilage*.
- The articular capsule is typically reinforced with ligaments and may contain bursae, or tendon sheaths that reduce friction where muscles, tendons, or ligaments cross bone.

ACTIVITY 3

Examining Synovial Joint Structure

Examine a beef joint to identify the general structural features of diarthrotic joints.

If the joint is freshly obtained from the slaughterhouse, put on disposable gloves before beginning your observations.

OBJECTIVE 2 Identify the types of synovial joints.

ACTIVITY 4

Demonstrating the Importance of Friction-Reducing Structures

1. Obtain a small water balloon and clamp. Partially fill the balloon with water (it should still be flaccid), and clamp it closed.

2. Position the balloon atop one of your fists and press down on its top surface with the other fist. Push on the balloon until your two fists touch, and move your fists back and forth over one another. Assess the amount of friction generated.

3. Unclamp the balloon and add more water. The goal is to get just enough water in the balloon so that your fists cannot come into contact with one another but remain separated by a thin water layer when pressure is applied to the balloon.

4. Once again, perform the same movements to assess the amount of friction generated.

How does the presence of a sac containing fluid influence the amount of friction generated? _____

What anatomical structure(s) does the water-containing balloon mimic?

_____

What anatomical structures might be represented by your fists?

ACTIVITY 5

Identifying Types of Synovial Joints

Synovial joints are divided into the following subcategories on the basis of the movements they allow. As you read through the description of each joint type, manipulate the joints identified as examples on yourself and on an articulated skeleton to observe its possible movements. Make sure you understand the terms *uniaxial, biaxial,* and *multiaxial.*

- *Plane:* Articulating surfaces are flat or slightly curved, allowing sliding movements in one or two planes. Examples are the intercarpal and intertarsal joints.
- *Hinge:* The rounded process of one bone fits into the concave surface of another to allow movement in one plane (uniaxial), usually flexion and extension. Examples are the elbow and interphalangeal joints.
- *Pivot:* The rounded or conical surface of one bone articulates with a shallow depression or foramen in another bone. Pivot joints allow uniaxial rotation, as in the joint between the atlas and axis (C_1 and C_2).
- *Condyloid:* The oval condyle of one bone fits into an oval depression in another bone, allowing biaxial (two-way) movement. The wrist joint and the metacarpophalangeal joints (knuckles) are examples.
- *Saddle:* Articulating surfaces are saddle shaped. The articulating surface of one bone is convex, and the abutting surface is concave. Saddle joints, which are biaxial, include the joint between the thumb metacarpal and the trapezium (a carpal) of the wrist.
- *Ball and socket:* The ball-shaped head of one bone fits into a cuplike depression of another. These multiaxial joints allow movement in all directions. Examples are the shoulder and hip joints.

Movements Allowed by Synovial Joints

OBJECTIVE 3 Define *origin* and *insertion* in relation to skeletal muscles.

Every muscle of the body is attached to bone (or other connective tissue structures) by at least two points—the **origin** (the stationary, immovable, or less movable attachment) and the **insertion** (the movable attachment). Body movement occurs when muscles contract across diarthrotic synovial joints (Figure 10.3). When the muscle contracts and its fibers shorten, the insertion moves toward the origin. The type of movement depends on the construction of the joint (uniaxial, biaxial, or multiaxial) and on the position of the muscle relative to the joint. The most common types of body movements are described below and illustrated in Figure 10.4.

OBJECTIVE 4 Demonstrate or identify the various body movements.

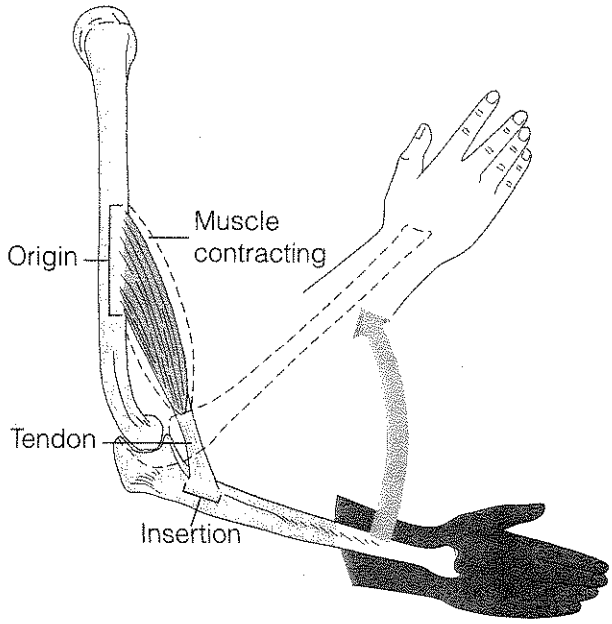


FIGURE 10.3 Muscle attachments (origin and insertion). When a skeletal muscle contracts, its insertion moves toward its origin.

ACTIVITY 6

Demonstrating Movements of Synovial Joints

Attempt to demonstrate each movement on a skeleton or on yourself as you read through the following material:

Flexion (Figure 10.4a and c): A movement, generally in the sagittal plane, that decreases the angle of the joint and reduces the distance between the two bones. Flexion is typical of hinge joints (bending the knee or elbow), but is also common at ball-and-socket joints (bending forward at the hip).

Extension (Figure 10.4a and c): A movement that increases the angle of a joint and the distance between two bones (straightening the knee or elbow). Extension is the opposite of flexion. If extension is greater than 180 degrees (for example, bending the trunk or head backward), it is termed *hyperextension* (Figure 10.4a).

Abduction (Figure 10.4d): Movement of a limb away from the midline or median plane of the body, generally on the frontal plane, or the fanning movement of fingers or toes when they are spread apart.

Adduction (Figure 10.4d): Movement of a limb toward the midline of the body. Adduction is the opposite of abduction.

Rotation (Figure 10.4b and e): Movement of a bone around its longitudinal axis. Rotation, a common movement of ball-and-socket joints, also describes the movement of the atlas around the odontoid process of the axis.

Circumduction (Figure 10.4e): A combination of flexion, extension, abduction, and adduction commonly observed in ball-and-socket joints like the shoulder. The proximal end of the limb remains stationary, and the distal end moves in a circle. The limb as a whole outlines a cone.

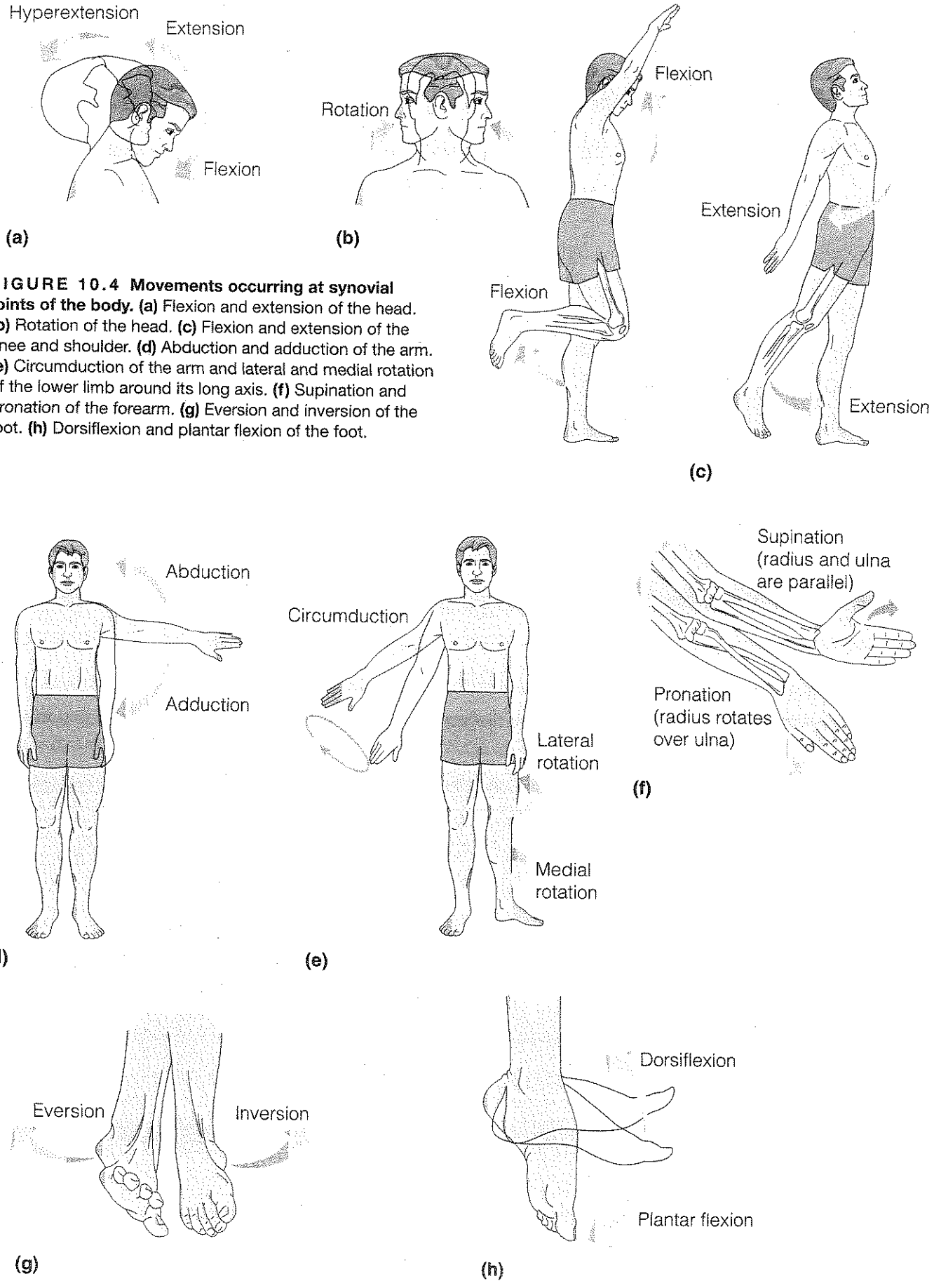


FIGURE 10.4 Movements occurring at synovial joints of the body. **(a)** Flexion and extension of the head. **(b)** Rotation of the head. **(c)** Flexion and extension of the knee and shoulder. **(d)** Abduction and adduction of the arm. **(e)** Circumduction of the arm and lateral and medial rotation of the lower limb around its long axis. **(f)** Supination and pronation of the forearm. **(g)** Eversion and inversion of the foot. **(h)** Dorsiflexion and plantar flexion of the foot.

Pronation (Figure 10.4f): Movement of the palm of the hand from an anterior or upward-facing position to a posterior or downward-facing position. This action moves the distal end of the radius across the ulna so that the two bones form an X.

Supination (Figure 10.4f): Movement of the palm from a posterior position to an anterior position (the anatomical position). Supination is the opposite of pronation. During supination, the radius and ulna are parallel.

The last four terms refer to movements of the foot:

Inversion (Figure 10.4g): A movement that results in the medial turning of the sole of the foot.

Eversion (Figure 10.4g): A movement that results in the lateral turning of the sole of the foot; the opposite of inversion.

Dorsiflexion (Figure 10.4h): A movement of the ankle joint in a dorsal direction (standing on one's heels).

Plantar flexion (Figure 10.4h): A movement of the ankle joint in which the foot is flexed downward (standing on one's toes or pointing the toes).

ACTIVITY 7

Demonstrating Uniaxial, Biaxial, and Multiaxial Movements

Using the information in the previous activity, perform the following demonstrations and complete the accompanying charts:

1. Demonstrate movement at two joints that are uniaxial.

Name of joint	Movement allowed

2. Demonstrate movement at two joints that are biaxial.

Name of joint	Movement allowed	Movement allowed

3. Demonstrate movement at two joints that are multiaxial.

Name of joint	Movement allowed	Movement allowed	Movement allowed

Joint Disorders

Most of us don't think about our joints until something goes wrong with them. Joint pains and malfunctions are caused by a variety of things. For example, a hard blow to the knee can cause a painful bursitis, known as "water on the knee," due to damage to the patellar bursa. Tearing a ligament may result in a painful condition that persists over a long period because these poorly vascularized structures heal so slowly.

Age also takes its toll on joints. Weight-bearing joints in particular eventually begin to degenerate. *Adhesions* (fibrous bands) may form between the surfaces where bones join, and excess bone tissue (*spurs*) may grow along the joint edges.

- If possible, compare an X-ray image of an arthritic joint to one of a normal joint.

NAME _____

LAB TIME/DATE _____

REVIEW SHEET 10 EXERCISE

Joints and Body Movements

Types of Joints

1. Use the key terms to identify the joint types described below.

Key: cartilaginous fibrous synovial

_____ 1. typically allows a slight degree of movement

_____ 2. includes joints between the vertebral bodies and the pubic symphysis

_____ 3. essentially immovable joints

_____ 4. sutures are the most remembered examples

_____ 5. cartilage connects the bony portions

_____ 6. have a fibrous articular capsule lined with a synovial membrane surrounding a joint cavity

_____ 7. all are freely movable or diarthrotic

_____ 8. bone regions are united by fibrous connective tissue

_____ 9. include the hip, knee, and elbow joints

2. Match the joint subcategories in column B with their descriptions in column A, and place an asterisk (*) beside all choices that are examples of synovial joints.

	Column A	Column B
_____	1. joint between most skull bones	ball and socket
_____	2. joint between the axis and atlas	condyloid
_____	3. hip joint	gliding
_____	4. joint between forearm bones and wrist	hinge
_____	5. elbow	pivot
_____	6. interphalangeal joints	saddle
_____	7. intercarpal joints	suture
_____	8. joint between the skull and vertebral column	symphysis
_____	9. joints between proximal phalanges and metacarpal bones	syndesmosis

3. What characteristics do all joints have in common? _____

_____

4. Describe the structure and function of the following structures or tissues in relation to a synovial joint, and label the structures indicated by leader lines in the diagram.

ligament _____

_____

articular cartilage _____

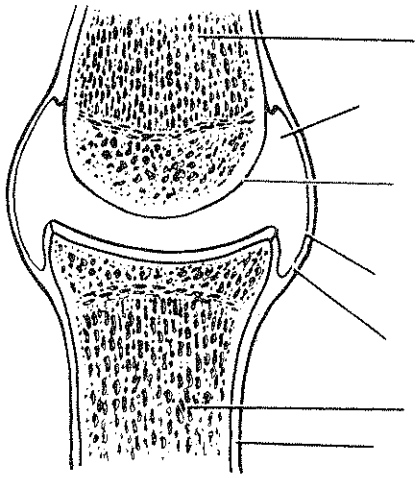
_____

synovial membrane _____

_____

_____

bursa _____



5. Which joint, the hip or the knee, is more stable? _____

Name two important factors that contribute to the stability of the hip joint.

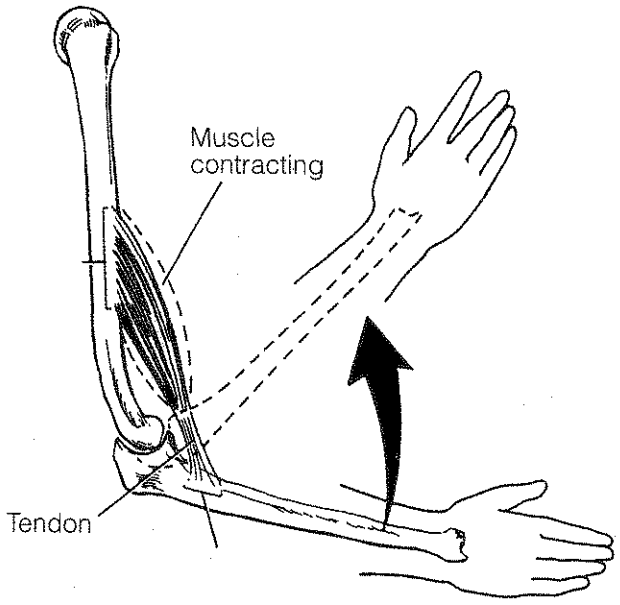
_____ and _____

Movements Allowed by Synovial Joints

6. Label the *origin* and *insertion* points on the diagram below and complete the following statement:

During muscle contraction, the _____

moves toward the _____.



7. Identify the movements demonstrated in the photos by inserting the missing words in the corresponding numbered answered blanks.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____