Chapter 2
The Skeletal System

Chapter Objectives

Upon completion of this chapter, you should be able to
1. identify and define medical terms associated with the major structures and functions of the skeletal system;
2. recognize, define, spell and pronounce terms related to the pathology, diagnosis, and treatment of skeletal system diseases and conditions; and
3. identify medical careers associated with the diagnosis and treatment of skeletal system diseases and conditions.

CASE STUDY
Mary O’Toole, an active, 46-year-old female with a healthy lifestyle, has been suffering from lower back pain as well as pain radiating down her right leg and calf. Recently Mary noticed increased aggravation of pain when sitting. She has tried over-the-counter pain medication, including Advil® and Tylenol®, but with no relief. After enduring the pain for two weeks, Mary made an appointment with her internist, Dr. Feeney. An internist, or internal medicine specialist, is a physician who specializes in the diagnosis, treatment, and prevention of disease in adults.

After examining Mary, Dr. Feeney referred her to Dr. Peter Lanips, who ordered X-rays of Mary’s lumbosacral (LS) spine. The lumbosacral (LUM-boh-SAY-kruhl) spine is the lower part of the vertebral column, made up of the lumbar region and the sacrum (the bone segment that connects the spine to the pelvis). The X-rays revealed a 2-centimeter bulge between vertebral disks L5 and S1 (lumbar vertebra 5 and sacral vertebra 1).

YOUR TURN
Based on the facts mentioned in the case study, what kind of procedure do you think Mary’s doctor will perform to alleviate her pain? Explain your answer. As you read through this chapter, you will learn medical terms that will help you understand the basic structure and functions of the skeletal system, as well as common diseases and conditions, diagnostic tests and procedures, and surgical and therapeutic treatments. You will refer back to this case study when you interpret Mary’s medical record in the Chapter Review.

Medical Word Parts

The many parts of the skeletal system can be distinguished by their unique names. Mastery of the combining forms, prefixes, and suffixes listed in the tables that follow will help you understand medical terms pertaining to the skeletal system.

Combining Forms

The combining forms that follow are common in medical terms used to describe conditions and procedures of the skeletal system.

<table>
<thead>
<tr>
<th>Combining Form</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>brach/o</td>
<td>arm</td>
</tr>
<tr>
<td>burs/o</td>
<td>bursa (sac of fluid near a joint)</td>
</tr>
<tr>
<td>carp/o</td>
<td>wrist</td>
</tr>
<tr>
<td>cervic/o</td>
<td>neck; cervix (neck of uterus)</td>
</tr>
<tr>
<td>chiz/o</td>
<td>hand</td>
</tr>
<tr>
<td>chondr/o</td>
<td>cartilage</td>
</tr>
<tr>
<td>cost/o</td>
<td>rib</td>
</tr>
<tr>
<td>cran/o</td>
<td>skull</td>
</tr>
<tr>
<td>kyph/o</td>
<td>humpback</td>
</tr>
<tr>
<td>lord/o</td>
<td>curve; swayback</td>
</tr>
<tr>
<td>lumb/o</td>
<td>lumbar region; loin</td>
</tr>
<tr>
<td>lux/o</td>
<td>slide</td>
</tr>
<tr>
<td>myel/o</td>
<td>bone marrow; spinal cord</td>
</tr>
<tr>
<td>narc/o</td>
<td>numbness; sleep; stupor</td>
</tr>
</tbody>
</table>

(Continued)
Combining Form | Meaning
---|---
 orth/o | straight
 os/e/o | bone
 ped/o | foot; child
 pod/o | foot
 pyret/o | fever
 rachi/o | spine; vertebra
 rheumat/o | watery flow
 sacr/o | sacrum
 sarc/o | flesh; connective tissue
 scoli/o | crooked; bent
 spondyl/o | vertebra; backbone
 ster/o | solid structure; steroid
 synovi/o | lubricating fluid of joints
 tars/o | ankle
 ten/o, tendin/o, tendon/o | tendon

Suffixes | Meaning
---|---
 -atum | process; condition
 -cess | surgical puncture to remove fluid
 -desis | to bind; tie together
 -ectomy | surgical removal; excision
 -itis | inflammation
 -malacia | softening
 -oid | like; resembling
 -oma | tumor; mass
 -osis | abnormal condition
 -penia | deficiency
 -plasty | surgical repair
 -porosis | abnormal condition of small holes
 -scopy | instrument used to view
 -tony | process of cutting; incision

Prefixes
The prefixes listed below are not specific to skeletal system terminology. These universal prefixes are used in many other medical terms, which you will learn as you progress through this book.

| Prefix | Meaning |
---|---|
 a-, an- | not; without |
 anti- | against |
 inter- | between |
 intra- | within; into |
 meta- | change; beyond |
 non- | not |
 peri- | around; surrounding |
 sub- | below; under |
 supra- | above |
 syn- | together; with |

Suffixes
The suffixes that follow are common in medical terms used to describe conditions and procedures of the skeletal system. You will encounter these suffixes in many other terms throughout this book.

| Suffix | Meaning |
---|---|
 -al, -ic | pertaining to |
 -algia | pain |

Anatomy and Physiology
The skeletal system is composed of the bones and related structures that aid body movement. It is divided into two major parts: the axial skeleton and the appendicular skeleton (Figure 2.1).

The axial skeleton consists of the bones along the axis, or central line, of the human body. The axial skeleton consists of the skull, facial bones, sternum (breastbone), ribs, and vertebral column.

The appendicular skeleton contains the bones in the appendages of the body, as well as the structures that connect the appendages to the axial skeleton. Specifically, the appendicular skeleton comprises the shoulder girdle; the arm, wrist, and hand bones; the pelvic girdle; and the leg, ankle, and foot bones.

Functions of Bone
The skeletal system serves five important functions in the human body.
- **Support**—The skeletal system provides structure and shape for the body.
- **Protection**—The skeletal system surrounds and protects the internal organs.
- **Mineral storage**—Calcium and phosphorus, two minerals that the body needs for important regulatory functions, are stored inside the bones.
- **Blood cell formation**—Red blood cells are manufactured in the bone marrow.

Figure 2.1 In this diagram, the axial skeleton is shown in a light magenta color to distinguish it from the appendicular skeleton.
• Anchoring and movement of muscles—The bones of the skeletal system act as levers for muscular action. Muscular movement would not be possible without tendons, fibrous cords of tissue that attach muscle to bone, and ligaments, fibrous cords of tissue that attach bone to bone.

**Bone Structure**

Bone is a dense connective tissue composed of collagen (KAH-luh-jen) fibers and minerals. Collagen fibers are resistant but flexible. They are also found in skin and cartilage. There are 206 bones of various sizes and shapes in the adult body (Figure 2.2). These bones can be classified in several ways.

**Long bones** are found in the extremities. Short bones are located in the hands and feet. They are cube-shaped, and composed of spongy bone, which allows for flexible movement. Flat bones protect vital organs and provide a broad surface area for muscle attachment. Examples of flat bones include the cranium (bones of the head), facial bones, scapulae (shoulder blades), and sternum (breastbone).

Sesamoid bones, so named because they resemble large sesame seeds, are embedded within tendons. Sesamoid bones facilitate joint movement and are found in the patella (kneecap) and in the hands, wrists, and feet.

**Irregular bones** have an unusual or complex shape and, therefore, cannot be categorized as long, short, or flat. They provide both support and protection yet allow flexible movement. Examples include the vertebrae (bones or bone segments of the spinal column), jawbones, and coccyx (tailbone).

The shaft of a long bone is called the **diaphysis** (digh-AF-uh-sis) (Figure 2.3). Each end of a long bone is called an **epiphysis** (uh-PIF-uh-sis). The **epiphyseal** (uh-PIF-uh-SEE-uhl) **plate**, also known as the **epiphyseal line or growth plate**, represents an area of cartilage tissue that is consistently being replaced by new, bony tissue as the bone grows. Cartilage cells at the edge of the growth plate form new bone. This process is responsible for the lengthening of bones during childhood and adolescence. The growth plate calcifies (hardens through calcium deposition) and disappears when the bone achieves its full growth.

**Bone Composition**

There are two basic types of bone tissue: cortical bone and cancellous bone (Figure 2.3).

Cortical bone, also called compact bone, is very dense, hard, and strong. This type of bone tissue lies under the **periosteum** (peer-ee-AHS-tee-um), or the outer membrane of a bone, and mainly around the diaphysis (shaft) of long bones. In long bones, cortical bone has a hollow center called the **medullary (MED-yoo-lair-ee) cavity**, which contains yellow bone marrow composed chiefly of fat cells.

Cancellous bone, or **trabecular** (truh-BEK-yoo-ler) bone, is much more porous and much less dense than compact bone. For these reasons, cancellous bone is commonly called **spongy bone**.

Cancellous bone is found mainly in the epiphyses (uh-PIF-uh-seez), or ends, of long bones. Spaces in the cancellous bone contain red bone marrow, where red blood cells, white blood cells, and platelets are manufactured. The production of blood cells in the bone marrow is called **hematopoiesis** (HEE-muh-toh-poy-EE-sis).

**Fascinating Fact**

If bone and steel were the same weight, the bones of the human body would be six times stronger than steel.

**Inquiring Minds**

What does the mineral calcium do for bones? Try this experiment at home or in class:

1. Overnight, soak two uncooked chicken legs in a jar of vinegar. Also soak two chicken legs in a jar of water.
2. Compare and contrast the vinegar-soaked and water-soaked chicken legs. What do you notice about the chicken legs that were immersed in vinegar compared to those soaked in water?
3. Record your findings and share them with the class.

**Joints**

A joint is any place in the body at which two or more bones connect, or articulate. Connective bands of tissue called ligaments connect bone to bone.
Bone Processes and Depressions

Joints require processes and depressions in bones. **Bone processes** are areas on bones that extend outward and serve as attachment zones for muscles and tendons (Figure 2.6). Important processes include tubercules, trochanters, tuberosities, and condyles. A **tubercle** (TOO-ber-kahl) is a small round process found on many bones. A **trochanter** is one of two large processes found on the femur, or thigh bone. A **tuberosity** (TOO-buh-RAH-sih-tee) is a large, rough process found on many bones. A **condyle** (KAHN-DIGH-uh-luhl) is a rounded-knuckle process at a joint.

### Axial Skeleton

The axial skeleton consists of the bones along the axis, or central part, of the human skeleton. The axial skeleton comprises the skull, thoracic cage, and vertebral column (spine).

### Bones of the Skull

The **skull** contains the cranial and facial bones. The **cranium** is made up of bones that protect the brain. The cranial bones attach to each other with the **cranial and facial bones**.

### Bone Processes and Depressions

1. **Synarthroses** (SIN-ar-THROH-seez)—immovable joints. Examples include the ribs and pelvis.
2. **Amphiarthroses** (AM-fee-ar-THROH-seez)—slightly movable joints. Examples include the cranial and facial bones.
3. **Diarthroses** (DIGH-ar-THROH-seez)—freely movable joints. Examples include ball-and-socket, hinge, gliding, pivot, condylar, and saddle joints.

### Synovial Membrane and Fluid

The small, fluid-filled bursa sacs of the knee act like cushions by reducing friction between bones during movement. The bursa sac contains the synovial fluid (Figure 2.5).

1. Roll up three sheets of paper (8½” x 11”) about 1 inch wide into a cylinder. Tape the cylinder closed so that it doesn’t unravel. The sheets of paper represent hollow bones.
2. Add weight to the paper plate using rocks, wooden blocks, coins, or household items such as a stapler or paperweights.
3. Observe how much weight the hollow paper bones can handle before they collapse.
4. Now roll up three more sheets of paper, as tightly as you can, so that there is no hollow section.
5. Repeat steps 2–4.
6. Record your observations. Then share them with the class.

### Joint Capsule

A **joint capsule** is a tough, elastic layer of tissue that surrounds a joint and helps hold the bones in place.

### Animation

![Animation](Image)

**Figure 2.4** Examples of the six different types of diarthroses, or freely movable joints.

**Figure 2.5** The small, fluid-filled bursa sacs of the knee act like cushions by reducing friction between bones, muscles, and tendons near the joints.

**Figure 2.6** Examples of bone processes and depressions in the femur, skull, humerus, and pelvis.

---

**Fascinating Fact**

You have more than 230 movable and semi-movable joints in your body.

There are three main types of joints:

- **Diarthroses** (DIGH-ar-THROH-seez)—freely movable joints. Examples include ball-and-socket, hinge, gliding, pivot, condylar, and saddle joints. Figure 2.4 shows the six categories of diarthrotic (freely movable) joints.
- **Amphiarthroses** (AM-fee-ar-THROH-seez)—slightly movable joints. Examples include rib joints and the pelvis.
- **Synarthroses** (SIN-ar-THROH-seez)—immovable joints. An example is the cranium.

Both ball-and-socket joints and hinge joints are also known as synovial (SIN-NOH-uh-uhl) joints because they contain a membrane that secretes synovial fluid. This fluid acts as a lubricant by reducing friction between bones during movement. The bursa sac contains the synovial fluid (Figure 2.5).

**Figure 2.25** The small, fluid-filled bursa sacs of the knee act like cushions by reducing friction between bones, muscles, and tendons near the joints.
other at joints called **sutures**. In newborns, the cranial bones are not completely joined. Rather, there are soft spots called **fontanels** (FAHN-TEHL-ehnts) between the cranial bones. These soft spots develop into bone in early infancy.

The cranium consists of the following bones:

- **The frontal bone** forms the forehead.
- **The parietal** (puh-RIHT-ih-uhl) **bones** form the roof and upper sides of the cranium.
- **The occipital** (ahk-SIP-ih-uhl) **bones** form the posterior floor and walls of the cranium.
- **The temporal** (TEM-uh-ruh-uhl) **bones** form the sides and base of the cranium.
- **The sphenoid** (SFEE-noyd) **bone** forms part of the base of the skull, and the floor and sides of the eye sockets.
- **The ethmoid** (ETH-meid) **bone** forms part of the nose, eye socket, and floor of the cranium. All facial bones except one are joined together by sutures, making them immovable. The **mandible**, or lower jawbone, is the only facial bone capable of movement. It enables us to speak and chew.

The bones of the thoracic cavity include the following:

- **There are 12 pairs of ribs called costals**, which attach posteriorly to the thoracic vertebrae. The rib cage contains 24 bones arranged in pairs of 12. The first seven pairs of costals are called **true ribs**, or **fixed ribs**, because they attach anteriorly to the sternum and posteriorly to the thoracic vertebrae. The remaining three pairs of ribs (8–10) are called **false ribs** because they indirectly attach to the sternum by connecting with the cartilage of the ribs above them. The last two pairs of costals (11 and 12) are called **floating ribs** because they are attached neither to the sternum nor to cartilage, but to the vertebrae.

- **The thoracic vertebrae**, made up of 12 vertebrae, serve as the posterior attachment for the ribs.

The bones that make up the face are as follows:

- **The nasal bones** form the bridge of the nose.
- **The vomer** (VOH-mer) **bone** is the septum, or dividing line, between the left and right cavities of the nose.
- **The zygomatic** (ZIGH-guh-MAT-ik) **bones** are the cheekbones.
- **The maxillary** (MAK-suh-lair-ee) **bones** form the upper jawbone.
- **The mandible** is the lower jawbone.
- **The palatine** (PAL-uh-tighn) **bone** forms the posterior part of the hard palate in the mouth.
- **The lacrimal** (LAK-rih-muhl) **bones** make up part of the eye socket. Each lacrimal bone contains a channel through which tears flow.

### Fascinating Fact

The stirrup bone of the middle ear is the smallest bone in the body. It is equivalent to the size of a grain of rice.

### Bones of the Thoracic Cage

The thorax, or rib cage, is made up of the sternum, ribs, and thoracic (thuh-RAS-ik) vertebrae. The rib cage, formally called the **thoracic cage**, is designed to protect many vital organs (Figure 2.8). Plenty of cartilage on the anterior of the thoracic cage allows for movement of the thorax during the act of breathing.

The bones of the thoracic cavity include the following:

- **The sternum** forms the breastbone, which serves as the anterior attachment for the ribs. The sternum is made up of three smaller sections: the **manubrium** (muh-NOO-uhm), the **body**, and the **xiphoid** (ZIGH-foid) **process**.
- **There are 12 pairs of ribs called costals**, which attach posteriorly to the thoracic vertebrae. The rib cage contains 24 bones arranged in pairs of 12. The first seven pairs of costals are called **true ribs**, or **fixed ribs**, because they attach anteriorly to the costal cartilage. The remaining three pairs of ribs (8–10) are called **false ribs** because they indirectly attach to the sternum by connecting with the cartilage of the ribs above them. The last two pairs of costals (11 and 12) are called **floating ribs** because they are attached neither to the sternum nor to cartilage, but to the vertebrae.
- **The thoracic vertebrae**, made up of 12 vertebrae, serve as the posterior attachment for the ribs.

### Bones of the Vertebral Column

The vertebreal column, or spine, is made up of 26 bone segments (Figure 2.9). These segments are arranged in five sections that surround and protect...
The Skeletal System

Chapter 2

Introduction to Medical Terminology

Fascinating Fact
Humans and giraffes have the same number of bones in their necks, but the vertebrae in a giraffe's neck are much, much larger.

Appendicular Skeleton

The appendicular skeleton is made up of 126 bones that attach to the axial skeleton as appendages. The appendicular skeleton comprises the shoulder girdles, arms, wrists, and hands in the upper part of the body and the pelvic girdle, legs, ankles, and feet in the lower part of the body.

Shoulder Girdle

The shoulder girdle is composed of bones that support attachment of the upper extremities to the axial skeleton. The bones that make up the shoulder girdle include the clavicle, commonly known as the collarbone; the sternum (breastbone); and the scapula, or shoulder blade. (See Figure 2.1.) The clavicle connects the sternum to the scapula.

Upper Extremities

The bones of the upper extremities, shown in Figure 2.1, are as follows:
- The humerus is the upper arm bone.
- The radius is the smaller bone found on the thumb side of the forearm.
- The ulna is the larger forearm bone. The proximal end of the ulna forms the elbow.
- Eight carpal bones make up the wrist.
- Five metacarpals (MET-uh-KAR-puhlz) form the bones of the hand.
- Fourteen phalanges (fuh-LAN-jeez) make up the finger bones; each finger (except the thumb) has three phalanges: proximal, medial, and distal. The thumb has only two phalanges: the proximal and distal phalanges.

Fascinating Fact
Of the 206 bones in the adult body, 54 of them are in your hands—27 in each hand.

Pelvic Girdle

The pelvic girdle is made up of bones that support attachment of the lower extremities to the axial skeleton (Figure 2.10). The bones that comprise the pelvic girdle are as follows:
- The ischium (IS-kee-um) is the posterior part of the pelvic bone.
- The ilium is the broad, blade-shaped bone that forms the upper part of each side of the pelvis.
- The pubis (PYOO-bis) is the anterior part of the pelvic bone.

Lower Extremities

The bones that make up the lower extremities, shown in Figure 2.1, are as follows:
- The femur, or thighbone, is the upper leg bone. It is the longest bone in the human body.
- The patella, or kneecap, is the bone that forms the anterior part of the knee.
- The tibia, or shinbone, is the larger, more medially located lower leg bone.
- The fibula, located laterally to the tibia, is the smaller of the two lower leg bones.
- Seven tarsal bones make up the ankle. The largest of these bones, called the calcaneus (kal-KAY-nee-us), is known as the heelbone. The next largest is the talus (anklebone).
- Five metatarsals (MET-uh-TAR-suhlz) comprise the bones of the foot.
- Each foot contains 14 phalanges. There are two phalanges (proximal and distal) in the big toe. There are three phalanges in each of the other four toes: proximal, medial, and distal phalanges.

Fascinating Fact
The longest bone in your body is your femur (thighbone). The femur is about one-quarter of your total height. The smallest bone in your body is the stirrup bone, or stapes (STAY-peez). Located inside the ear, the stapes can measure one-tenth of an inch. This tiny bone carries sound vibrations to the cochlea, a spiral-shaped structure in the inner ear that generates nerve impulses in response to the vibrations.
Diseases and Conditions

Because the skeletal system encompasses the bones and the joints, in this section you will learn about pathological conditions that affect bones, joints, or both. Rheumatoid arthritis, for example, is a chronic disease that affects both the joints and the bones. A patient with rheumatoid arthritis experiences painful inflammation in the lining of the joints. This inflammation causes deformity of the joints and erosion of bone.

Diseases and conditions common to the skeletal system are described in the following list.

<table>
<thead>
<tr>
<th>Disease/Condition</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ankylosing spondylitis</td>
<td>A form of rheumatoid arthritis characterized by inflammation of vertebral joints, which can become fused and stiff; <em>rheumatoid arthritis of the spine</em>.</td>
</tr>
<tr>
<td>ankylosis</td>
<td>A stiff joint caused by adhesion, or abnormal fusion of two bones into one.</td>
</tr>
<tr>
<td>arthralgia</td>
<td>Pain in a joint or joints.</td>
</tr>
<tr>
<td>arthritis</td>
<td>Inflammation of joints; usually accompanied by pain and, frequently, structural changes in bone and cartilage.</td>
</tr>
<tr>
<td>osteoarthritis</td>
<td>Joint disease that most often affects cartilage between the bone and joint; also known as degenerative joint disease (DJD).</td>
</tr>
<tr>
<td>rheumatoid arthritis (RA)</td>
<td>A chronic, systemic disease characterized by inflammation, pain, and stiffness in the joints; results in crippling deformities. (Figure 2.11)</td>
</tr>
<tr>
<td>bunion</td>
<td>Joint swelling at the base of the great toe, caused by inflammation of the bursa.</td>
</tr>
<tr>
<td>bursitis</td>
<td>Inflammation of the bursa, usually between bony protrusions and muscle or tendon. Examples include rotator cuff injury in the shoulder, tennis elbow, and knee injury.</td>
</tr>
<tr>
<td>chondromalacia</td>
<td>Softening of the cartilage.</td>
</tr>
<tr>
<td>dislocation</td>
<td>Total displacement of a bone from its joint; <em>luxation</em>.</td>
</tr>
<tr>
<td>fracture</td>
<td>A break in a bone.</td>
</tr>
<tr>
<td>Colles (KAH-leez) fracture</td>
<td>A fracture of the distal radius (bone on the thumb side of the forearm) that results from a fall onto an outstretched hand.</td>
</tr>
<tr>
<td>comminuted (KAH-mih-NEW-ted) fracture</td>
<td>A bone that has splintered or has been crushed (Figure 2.12).</td>
</tr>
<tr>
<td>compound fracture</td>
<td>A broken bone with an open wound leading to the site of the fracture, or bone that protrudes through the skin; also called <em>open fracture</em> (Figure 2.13).</td>
</tr>
<tr>
<td>greenstick fracture</td>
<td>An incomplete fracture; the bone is bent and partially broken. This type of fracture occurs primarily in children (Figure 2.14).</td>
</tr>
<tr>
<td>longitudinal fracture</td>
<td>A fracture that runs parallel to the long axis of the bone (Figure 2.15).</td>
</tr>
<tr>
<td>oblique (ahb-LEEK) fracture</td>
<td>A break across the bone at an angle (Figure 2.16).</td>
</tr>
<tr>
<td>pathologic fracture</td>
<td>A fracture resulting from pressure on weakened bone; due to osteoporosis or cancer, for instance (Figure 2.17).</td>
</tr>
<tr>
<td>simple fracture</td>
<td>A broken bone that does not penetrate the skin; also called <em>closed fracture</em> (Figure 2.18).</td>
</tr>
<tr>
<td>spiral fracture</td>
<td>A fracture in which the bone has been twisted apart; a common sports injury (Figure 2.19).</td>
</tr>
<tr>
<td>Disease/Condition</td>
<td>Definition</td>
</tr>
<tr>
<td>------------------</td>
<td>------------</td>
</tr>
<tr>
<td>fracture (continued)</td>
<td>A small crack in bone resulting from chronic, excessive impact; an overuse injury.</td>
</tr>
<tr>
<td>stress fracture</td>
<td>A fracture that runs straight across the bone, at a right angle to the long axis. It is often caused by a direct blow or prolonged stress, such as from running (Figure 2.20).</td>
</tr>
<tr>
<td>transverse fracture</td>
<td>A fracture that runs straight across the bone, at a right angle to the long axis. It is often caused by a direct blow or prolonged stress, such as from running (Figure 2.20).</td>
</tr>
<tr>
<td>herniated disk</td>
<td>Intervertebral disk that has slipped or ruptured (Figure 2.21).</td>
</tr>
<tr>
<td>lumbago</td>
<td>Pain in the lower back (lumbar) region.</td>
</tr>
<tr>
<td>myeloma</td>
<td>Cancer of the plasma cells (a type of white blood cell) that originates in the bone marrow.</td>
</tr>
<tr>
<td>ostealgia</td>
<td>Pain in the bone.</td>
</tr>
<tr>
<td>osteitis or ostitis</td>
<td>Inflammation of the bone.</td>
</tr>
<tr>
<td>osteochondroma</td>
<td>Tumor or bony projection that covers cartilage.</td>
</tr>
<tr>
<td>osteoma</td>
<td>Tumor of the bone.</td>
</tr>
<tr>
<td>osteomalacia</td>
<td>Abnormal softening of the bone. In children, this condition is known as rickets.</td>
</tr>
<tr>
<td>osteomyelitis</td>
<td>Inflammation of the bone and bone marrow (Figure 2.22).</td>
</tr>
</tbody>
</table>

**Figure 2.20** Transverse fracture.

**Figure 2.21** Herniated disk.

**Figure 2.22** Osteomyelitis.

**Disease/Condition**

- **osteopenia**
  - AHS-tee-oh-PEE-nee-uh
  - oste/o = bone
  - -penia = deficiency
  - Bone deficiency; in a young person, less-than-average bone density.

- **osteoporosis**
  - AHS-tee-oh-puh-ROH-sis
  - oste/o = bone
  - -porosis = abnormal condition of small holes
  - Condition of small holes in the bones; noticeable loss of bone density (Figure 2.23).

- **osteosarcoma**
  - AHS-tee-oh-sar-KOH-muh
  - oste/o = bone
  - sarc/o = flesh; connective tissue
  - -oma = tumor; mass
  - Malignant tumor that arises from connective tissue and affects the bone.

- **Paget's disease**
  - PAH-juh-ets
  - periostitis
  - -itis = inflammation
  - Excessive breakdown of bone and abnormal, enlarged bone formation; osteitis deformans (AHS-tee-IGH-tis duh-FOHR-menz).

- **periostitis**
  - PEER-ee-ahs-IGH-tis
  - peri- = around; surrounding
  - oste/o = bone
  - -itis = inflammation

- **sequestrum**
  - suh-KWES-trum
  - Bone tissue death that occurs when the bone has become sequestered, or separated, from the healthy tissue around it, due to lack of blood supply.

- **spina bifida**
  - SPIG-nah BIF-i-duh
  - Split spine; congenital defect in which part of the membrane covering the spinal cord protrudes through a gap in the spine (Figure 2.24).

- **spinal curvatures**
  - Figure 2.23 Osteoporosis.
  - kyphosis
    - kigh-FOH-sis
    - kyph/o = humpback
    - -osis = abnormal condition
    - Abnormal curvatures of the spine.
  - lordosis
    - lord/o = curve; swayback
    - -osis = abnormal condition
    - Abnormal, forward curvature of the lumbar spine; swayback (Figure 2.26).
  - scoliosis
    - skoh-LEE-oh-IGH-sis
    - scoli/o = crooked; bent
    - -osis = abnormal condition
    - Abnormal, lateral curvature of the spine (Figure 2.27).
**Disease/Condition**

**spondylolisthesis**  
SPYNd-uh-LOh-sis  
- spondyl/o = vertebra; backbone  
- osis = abnormal condition

**sprain**  
Trauma to the ligaments surrounding a joint, causing pain and, in some cases, disability.

**subluxation**  
sub- = below; under  
-lux/o = slide  
-ation = process; condition

**talipes**  
TAL-ih-peez

**tendinitis, tendonitis**  
ten-duh-NIGH-tis  
-tendin/o, tendon/o = tendon  
-itis = inflammation

**Fascinating Fact**

Pectus excavatum (PEK-tus ek-skuh-VAY-tum), commonly known as “funnel chest,” is a condition in which the sternum (breastbone) is abnormally depressed (displaced inward). The condition is thought to be congenital. The term pectus excavatum comes directly from the Latin words pectus (breast), ex (a prefix meaning “out” or “away from”), and cavus (“hollow”). The suffix -um is a noun form that means “structure.”

---

**Diagnostic Tests and Procedures**

A diagnostician uses different kinds of tools and methods to aid in pinpointing the cause of patients’ health problems. Following are some of the most common tests and procedures used to diagnose (identify) diseases and conditions of the skeletal system.

<table>
<thead>
<tr>
<th>Test/Procedure</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>arthroscopy</td>
<td>Visual examination of a joint using a scope (Figure 2.29).</td>
</tr>
<tr>
<td>bone density test</td>
<td>X-ray test that determines loss of, or changes in, bone density. It is used to diagnose diseases such as osteomalacia, osteoporosis, and osteopenia. Also called bone densitometry (den-sih-TAH-muh-tree) (Figure 2.30).</td>
</tr>
</tbody>
</table>

---

**Figure 2.25** Kyphosis.

**Figure 2.26** Lordosis.

**Figure 2.27** Scoliosis.

**Figure 2.28** Talipes.

**Figure 2.29** Arthroscopy.

**Figure 2.30** Bone density test.
Test/Procedure  Definition
bone marrow aspiration  Process involving the use of a syringe and needle to withdraw bone marrow liquid; used in medical procedures such as stem-cell transplant.
bone scan  A nuclear scanning test that identifies bone fractures, tumors, or infections.
computerized tomography (CT)  Process in which radiographic images of a specific section of the body are taken from multiple angles and then analyzed by a computer to identify bone injury or disease. CT scans provide more detailed imagery than standard X-rays (Figure 2.31).
lumbar puncture  Spinal tap; needle aspiration of spinal canal fluid in the lumbar area (Figure 2.32).
magnetic resonance imaging (MRI)  A noninvasive scanning test that involves use of an electromagnetic field and radio waves to visualize soft-tissue structures.
rheumatoid factor (RF)  A blood test performed to diagnose rheumatoid arthritis.
X-ray  Radiographic image used to diagnose skeletal changes in the body.

Surgical Procedures and Therapeutics
Once a pathological condition has been diagnosed, a treatment can be planned and implemented. For instance, when an X-ray shows a simple fracture of the wrist, the treatment of choice may be a closed reduction and internal fixation (CRIF). This procedure involves manual manipulation of the fracture to set the bones in proper alignment without surgical intervention.

Following is a list of common surgical and noninvasive treatments for diseases and conditions of the skeletal system.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>amputation</td>
<td>Removal of a limb, usually surgical; for example, above-the-knee amputation.</td>
</tr>
<tr>
<td>arthrocentesis</td>
<td>Surgical puncture of the joint space with a needle to remove accumulated fluid (Figure 2.33).</td>
</tr>
<tr>
<td>arthrodesis</td>
<td>Surgical immobilization of a joint.</td>
</tr>
<tr>
<td>arthroplasty</td>
<td>Surgical repair of a joint.</td>
</tr>
<tr>
<td>bone grafting</td>
<td>Process of transplanting and implanting tissue from one part of the body to another; used to repair a defect or injury.</td>
</tr>
<tr>
<td>bursectomy</td>
<td>Surgical removal of the bursa.</td>
</tr>
<tr>
<td>closed reduction and internal fixation (CRIF)</td>
<td>External manipulation to restore a fractured bone to normal position.</td>
</tr>
<tr>
<td>cast</td>
<td>Solid mold of a body part; used to immobilize fractures or dislocations.</td>
</tr>
<tr>
<td>splint</td>
<td>An appliance made of bone, wood, metal, or plaster of Paris; used for fixation of an injured body part.</td>
</tr>
<tr>
<td>traction</td>
<td>Application of a pulling force to align a dislocated part of the body.</td>
</tr>
</tbody>
</table>
Treatment

diskectomy
dis-KEK-toh-mee
Surgical removal of a herniated (ruptured) vertebral disk.

open reduction and internal fixation (ORIF)

orthosis
or-THOH-sis
orth/o = straight
-osis = abnormal condition
Surgical correction of a bone deformity.

osteoplasty
AHS-toe-uh-PLAS-toe
oste/o = bone
-plasty = surgical repair
Surgical correction of the bone.

osteotomy
AHS-toe-uh-tuh-mee
oste/o = bone
-tomy = process of cutting; incision
Incision to, or cutting of, a tendon.

orthosis
or-THOH-sis
orth/o = straight
-osis = abnormal condition
Skeletal straightening or correction of a bone deformity.

physical therapy
Physical rehabilitation that focuses on restoring physical function and preventing disability.

prosthesis
prahs-THEE-sis
Artificial replacement for a missing body part; such as an extremity (arm or leg).

spondylosyndesis
SPAHN-dih-loh-sin-DEE-sis
spondyl/o = vertebra; backbone
syn- = together; with
-desis = to bind; tie together
Surgical fusion of joints (ankylosis) between vertebral; spinal fusion (Figure 2.34).

Common Medical Abbreviations

The following medical abbreviations are commonly used in reference to the skeletal system. These abbreviations provide a shorthand method of communication among healthcare professionals concerning pathological conditions, diagnostic tests, surgical procedures, and therapeutic treatments. These abbreviations can be found in this chapter and in the medical record activity that follows.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATT PHYS</td>
<td>attending physician</td>
<td>MRI</td>
<td>magnetic resonance imaging</td>
</tr>
<tr>
<td>BP</td>
<td>blood pressure</td>
<td>NSAID</td>
<td>nonsteroidal anti-inflammatory drug</td>
</tr>
<tr>
<td>CRIF</td>
<td>closed reduction and internal fixation</td>
<td>ORIF</td>
<td>open reduction and internal fixation</td>
</tr>
<tr>
<td>CT</td>
<td>computerized tomography; computed tomography</td>
<td>PO, p.o.</td>
<td>by mouth (from the Latin per os)</td>
</tr>
<tr>
<td>CV</td>
<td>cardiovascular</td>
<td>PRN, p.r.n.</td>
<td>as needed (from the Latin pro re nata)</td>
</tr>
<tr>
<td>DJD</td>
<td>degenerative joint disease</td>
<td>Pt. pl.</td>
<td>patient</td>
</tr>
<tr>
<td>GI</td>
<td>gastrointestinal</td>
<td>Q4H</td>
<td>every four hours (from the Latin quaque quarta hora)</td>
</tr>
<tr>
<td>L</td>
<td>left</td>
<td>R</td>
<td>right</td>
</tr>
<tr>
<td>LBP</td>
<td>lower back pain</td>
<td>RA</td>
<td>rheumatoid arthritis</td>
</tr>
<tr>
<td>LS</td>
<td>lumbosacral</td>
<td>RF</td>
<td>rheumatoid factor</td>
</tr>
<tr>
<td>LS–S1</td>
<td>lumbar vertebra 5 to sacral vertebra 1</td>
<td>y/o</td>
<td>years old; year-old</td>
</tr>
<tr>
<td>mg</td>
<td>milligram(s)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Careers to Consider

If you pursue any of the following careers, you will interact on a regular basis with patients who have conditions or diseases of the skeletal system. For more detailed information on the career opportunities discussed on this page, visit the US Bureau of Labor Statistics website.

Chiropractor

Chiropractors treat illness and injury of the neuromusculoskeletal system, which includes nerves, muscles, ligaments, and tendons. These specialists treat patients primarily by manual manipulation or adjustment of parts of the body, especially the spinal column. They may use X-rays to help locate the source of a patient’s health problem. Chiropractors may combine manipulative therapy techniques with adjunctive therapies such as acupuncture and ultrasound. They also recommend dietary modifications, supportive devices, and exercises designed to improve physical health. They do not prescribe drugs or surgery, but refer patients to other healthcare professionals when necessary.

Chiropractors must hold a Doctor of Chiropractic (DC) degree and a state license. A Doctor of Chiropractic program generally takes four years to complete. Most chiropractors work independently or in a group practice.

Physical Therapist

Physical therapists (PTs) work with a patient’s doctor to develop a plan for restoring and maintaining the patient’s maximum movement and functional ability. They use specific exercises, manual manipulation, and other physical therapy interventions, and they educate patients about ways to improve their mobility and manage their pain. PTs also work with individuals to prevent loss of mobility by developing customized fitness- and wellness-oriented programs.

Physical therapists are required to hold a Doctor of Physical Therapy (DPT) degree and a license in their state of practice. PTs typically are employed in private offices, hospitals, clinics, nursing homes, and rehabilitative centers.

Orthopedic Surgeon

Orthopedics (or-thoh-PEE-di) is a branch of medicine focused on treating or correcting musculoskeletal conditions, including spine and joint injuries or deformities. Orthopedic surgeons are physicians who specialize in the diagnosis and treatment of spinal disorders, sports injuries, arthritis, and fractures. Orthopedic surgeons must hold a Medical Doctor (MD) or a Doctor of Osteopathic Medicine (DO) degree.

Prosthetist

A prosthetist (PRAHS-thuh-tist) is a person who measures, designs, fabricates, fits, and services a prosthesis (prahs-THEE-sis), or artificial limb. A prosthesis is prescribed by a licensed physician for the replacement of an extremity due to amputation, congenital deformity, or absence. A prosthetist must have at least a master’s degree and complete a one-year residency to obtain certification.

Radiologic Technologist

Radiologic technologists perform diagnostic imaging (X-rays) of the body for diagnosis or treatment of health conditions. They may find employment in hospitals, doctors’ offices, or cancer treatment centers. A radiologic technologist typically holds an associate’s degree. Some states require licensing or certification.

Chapter 2 Review

For each exercise that follows, write your answers on a separate sheet of paper.

Identify the Anatomical Structure

Directions: Identify the correct anatomical term that corresponds to each letter in the diagram.


Chapter 2 Review

Word Surgery
Directions: Dissect each medical term into its word parts. Identify the word-part types (prefix, combining form, or suffix), and write the meaning(s) of each word part. Then write a definition of the term.

Example: osteomyelitis
Dissection: oste/o/myel/oitis
oste/o (combining form) = bone
myel/o (combining form) = bone marrow
-itis (suffix) = inflammation
Definition: inflammation of the bone and bone marrow
1. arthritis
2. ostealgia
3. osteomalacia
4. osteoporosis
5. chondromalacia
6. myeloma
7. osteitis
8. bursitis
9. osteoarthritis
10. arthroscopy
11. spondylitis
12. synovial

Anatomy and Physiology
Directions: Provide the correct term(s) for each item that follows.
1. What are the two major parts of the human skeleton?
2. Name two examples of long bones.
3. Name two examples of flat bones.
4. What is the term for the bones in the fingers and toes?
5. What is the end of a long bone called?
6. What is the term for the shaft of a long bone?
7. Name the term for the growth zone located between the epiphysis and diaphysis.
8. Name the structure within bone that contains yellow marrow composed mainly of fat cells.
9. What is the term for the membrane that covers bone?
10. Name the term for the point at which two or more bones articulate (join together).

Word Construction
Directions: Using word parts and meanings presented in the chapter, build the medical term described in each definition that follows.
1. surgical repair of a joint
2. abnormal stiffening of a joint
3. softening of cartilage
4. incision to the skull
5. pertaining to (being located) around the bone
6. pertaining to between the ribs
7. pertaining to inside the ribs
8. pertaining to below the ribs
9. pertaining to inside the ribs
10. pertaining to below the ribs

Spelling
Directions: Identify the correctly spelled medical term in each numbered item.
1. arthritis
2. appendicular
3. thoracic
4. cranial
5. osteoporosis
6. classical
7. epiphysitis
8. amphetamine
9. epiphyseal
10. synovial

Pronunciation
Directions: Pronounce each term below, then write the correct spelling.
1. uh-PIF-uh-sis
2. MED-yoo-lair-ee
3. DIGH-ar-THROH-seez
4. KAHK-siks
5. fuh-LAN-jeez
6. met-uh-TAR-suhlz
7. MAK-droh-LAY-shuh
8. synoveal
9. sinoveal

Interpreting Abbreviations
Directions: Write the correct medical term or phrase for each abbreviation listed.
1. RA
2. LS
3. MRI
4. R
5. y/o
6. PRN
7. DJD
8. BP

Search the Source
Throughout this text, under the supervision of your instructor, you will investigate various electronic and print media to answer questions such as those below. In most cases you will be required to integrate resources and interpret technical material. These tasks will help prepare you for a career in healthcare.
1. Juvenile arthritis (JA) is being increasingly diagnosed in people younger than 16 years of age in the United States. Visit the Centers for Disease Control and Prevention (CDC) website and search for information about JA. What age group is JA most commonly diagnosed in? Does JA occur more frequently in boys or in girls? What does this fact suggest? How does geographic location impact JA?
2. Make a list of what you think are the five most commonly broken bones in the human body. Then use reliable resources to research the answer. Prepare a report for the class, describing your findings in clear, concise, effective language. Ask classmates for feedback on the effectiveness of your language.
Chapter 2 Review

Medical Record Practice

Following is a preoperative history report for Mary, the patient who was introduced in the Case Study. A preoperative history report is submitted to a hospital before a patient is admitted for surgery. Read Mary’s medical report. Then, on a separate sheet of paper, write a definition for each highlighted term and abbreviation.

**HOLLAND MEDICAL CENTER**
987 Medical Drive, Hospital City, US 12345-6789
PHONE: (098) 765-4321 FAX: (098) 483-2910

**PREOPERATIVE HISTORY**

PT NAME: Mary O’Toole
ID NO: 43370056
ROOM NO: 304
DATE OF ADMISSION: 11/15/20xx
ATT PHYS: Peter Lanips, MD

**History of Present Illness:**
The patient is a 46 y/o white female with a chief complaint of LBP radiating to R leg and calf. Pain worsens when patient bends over or attempts to touch toes. Sitting aggravates R leg and calf pain. Previous X-ray shows 2 cm bulge of disk between L5 and S1. Patient is admitted at this time for elective L5–S1 diskectomy. Surgery has been discussed with patient. The patient’s internist is Fred Feeney, MD.

**Medications:**
Tylenol 500 mg 2 PO Q4H PRN, pain; Advil 200 mg 2 PO Q4H PRN, pain.

**Past Medical History:**
Usual childhood diseases.

**Past Surgical History:**
None.

**Family History:**
Mother and grandmother have history of arthritis.

**Gynecological History:**
Regular menses (menstrual period).

**Social History:**
Pt. is a nonsmoker. Alcohol use is limited to 2–3 glasses of wine a week. Drug use denied.

**Review of Systems:**
CV (cardiovascular): No high BP, heart murmurs, or shortness of breath.
Palmonary: No chronic lung disease; no asthma.
GI (gastrointestinal): No hepatitis (inflammation of the liver).
Renal (pertaining to the kidney): Negative for infections.
Endocrine (relating to hormone-secreting glands in the body): No diabetes or thyroid disease.
Musculoskeletal (pertaining to the muscles and bones): Positive for early signs of arthritis.
Hematologic (pertaining to the blood): No history of anemia (deficiency of red blood cells or hemoglobin, the main protein in blood cells) or bleeding tendencies.

Peter Lanips, MD

---

**Cumulative Review**

Chapter 1: The Basics and the Body
Chapter 2: The Skeletal System

**Directions:** This review covers word parts, medical terms, and key concepts that you learned in Chapter 1: The Basics and the Body and Chapter 2: The Skeletal System. Write your answers to each exercise on a separate sheet of paper.

**Word Parts**

Directions: Write the meaning(s) of each word part. Identify each word part by type (prefix, combining form, or suffix).

1. gastr/o
2. crani/o
3. -scopy
4. oste/o
5. sub-
6. -logy
7. arthr/o
8. -ectomy
9. -ary
10. hypo-
11. orth/o
12. poster/o
13. cardi/o
14. proxim/o
15. hyper-
16. -itis
17. -osis
18. chondr/o
19. bi/o
20. dist/o
21. a-, an-

**Word Construction**

Directions: Build the medical term described in each definition.

1. inflammation of the joints
2. pertaining to the front of the body
3. study of cells
4. study of tissues
5. pain in the joint(s)
6. pertaining to the rib(s)
7. softening of cartilage
8. pain in a bone
9. surgical repair of a joint
10. pertaining to far away from the point of origin

**Word Surgery**

Directions: Divide each medical term into its word parts. Identify each word part (prefix, combining form, or suffix). Then write a definition of the term.

1. arthritis
2. osteoporosis
3. ankylosis
4. osteitis
5. spondylitis
6. osteoarthrits
7. arthroscopy
8. scoliosis
9. intercostal

**Pronunciations**

Directions: Write the correct spelling of the medical term for each pronunciation listed.

1. fuh-LAN-jeez
2. AHS-tay-oh-puh-ROH-sis
3. met-uh-TAR-suhlz
4. DIGH-ar-THROH-seez
5. uh-PIF-uh-sis
6. AR-throh-PLAS-tee
7. KAHN-droh-muh-LAY-shuh
8. seh-FAL-ik
9. peer-ee-AHS-tee-um
10. sib-NOH-vay-uhl
11. ahk-SIP-ih-tuhl
12. mid-SAJ-ih-tuhl

---

(Continued)
Military Time

Directions: Convert the military times to standard times, and the standard times to military times.

1. 0600
2. 1830
3. 2200
4. 0145
5. 4:00 a.m.
6. 12:30 a.m.
7. 1:20 p.m.
8. 6:35 p.m.

Anatomical Planes

Directions: Identify each anatomical plane shown.

1. 2.

Anatomical Locations and Positions

Directions: Match each term on the left with the correct meaning on the right.

1. dorsal
2. ventral
3. anterior
4. superior
5. inferior
6. distal
7. lateral
8. proximal
9. medial
10. posterior

a. near the top of the head
b. front of the body
c. near the side of the body
d. away from the point of origin
e. tail end (rear) of the body
f. near the point of origin
g. back of the body; spinal column
h. near the midline (center) of the body
i. near the soles of the feet
j. “belly” side of the body

Abbreviations

Directions: Write the correct abbreviation for each term.

1. milligram(s)
2. years old; year-old
3. patient
4. left
5. right
6. as needed
7. lumbosacral
8. by mouth
9. nothing by mouth
10. degenerative joint disease
11. magnetic resonance imaging
12. no known drug allergies
13. closed reduction and internal fixation
14. blood pressure
15. rheumatoid factor
16. nonsteroidal anti-inflammatory drug
17. open reduction and internal fixation
18. attending physician