

The Skeletal System

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CHAPTER

1

The Skeletal System

Lesson Objectives

- Identify the main tissues and organs of the skeletal system.
- List four functions of the skeletal system.
- Describe three movable joints.
- Identify two nutrients that are important for a healthy skeletal system.
- Describe two skeletal system injuries.

Check Your Understanding

- What is an organ system?
- What is connective tissue?

Vocabulary

- ball and socket joint
- bone marrow
- cartilage
- fracture
- gliding joint
- hinge joint
- joint
- ligament
- movable joint
- pivot joint
- skeletal system
- skeleton
- sprain

Your Skeleton

How important is your skeleton? Can you imagine your body without it? You would be a wobbly pile of muscle and internal organs, and you would not be able to move.

Your skeleton is important for many different things. Bones are the main organs of the skeletal system. They are made up of living tissue. Humans are vertebrates, which are animals that have a backbone. The sturdy set of bones and cartilage that is found inside vertebrates is called a **skeleton**.

The adult human skeleton has 206 bones, some of which are named in **Figure 1.1**. Strangely, even though they are smaller, the skeletons of babies and children have many more bones and more cartilage than adults have. As a child grows, these “extra” bones grow into each other, and cartilage slowly hardens to become bone tissue.

Living bones are full of life. They contain many different types of tissues. **Cartilage** is found at the end of bones and is made of tough protein fibers called collagen. Cartilage creates smooth surfaces for the movement of bones that are next to each other, like the bones of the knee.

Ligaments are made of tough protein fibers and connect bones to each other. Your bones, cartilage, and ligaments make up your **skeletal system**.

Functions of Bones

Your skeletal system gives shape and form to your body, but it is also important in maintaining homeostasis. The main functions of the skeletal system include:

- **Support.** The skeleton supports the body against the pull of gravity, meaning you don’t fall over when you stand up. The large bones of the lower limbs support the rest of the body when standing.
- **Protection.** The skeleton supports and protects the soft organs of the body. For example, the skull surrounds the brain to protect it from injury. The bones of the rib cage help protect the heart and lungs.
- **Movement.** Bones work together with muscles to move the body.
- **Making blood cells.** Blood cells are mostly made inside certain types of bones.
- **Storage.** Bones store calcium. They contain more calcium than any other organ. Calcium is released by the bones when blood levels of calcium drop too low. The mineral phosphorus is also stored in bones.

Structure of Bones

Bones are organs. Recall that organs are made up of two or more types of tissues. Bones come in many different shapes and sizes, but they are all made of the same materials.

The two main types of bone tissue are compact bone and spongy bone.

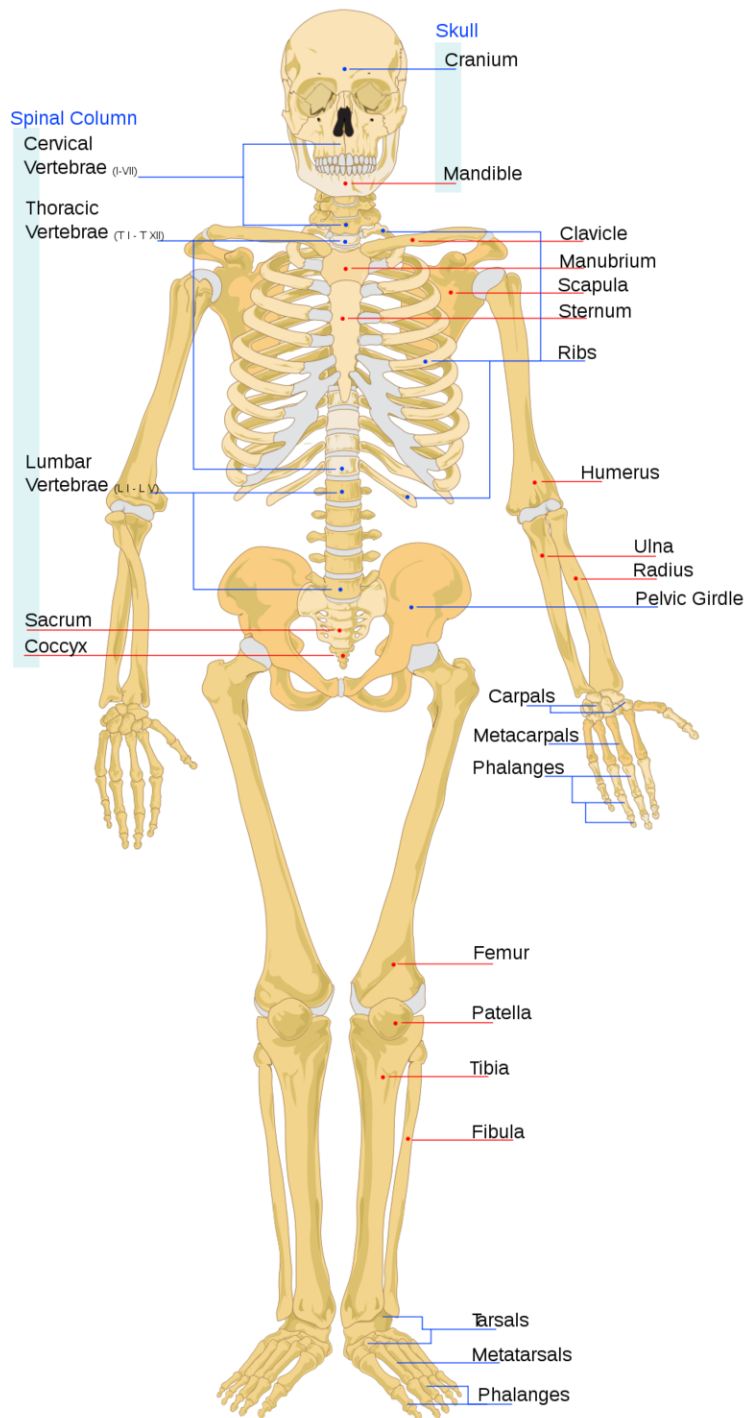
- Compact bone makes up the dense outer layer of bones.
- Spongy bone is found at the center of the bone, and is lighter and less dense than compact bone.

Bones look tough, shiny, and white because they are covered by a layer called the periosteum. Many bones also contain a soft connective tissue called **bone marrow**. There are two types of bone marrow - red marrow and yellow marrow.

- Red marrow makes red blood cells, platelets, and most of the white blood cells for the body (discussed in the *Diseases and the Body’s Defenses* chapter).
- Yellow marrow makes white blood cells.

The bones of newborn babies contain only red marrow. As children get older, some of their red marrow is replaced by yellow marrow. In adults, red marrow is found mostly in the bones of the skull, the ribs, and pelvic bones.

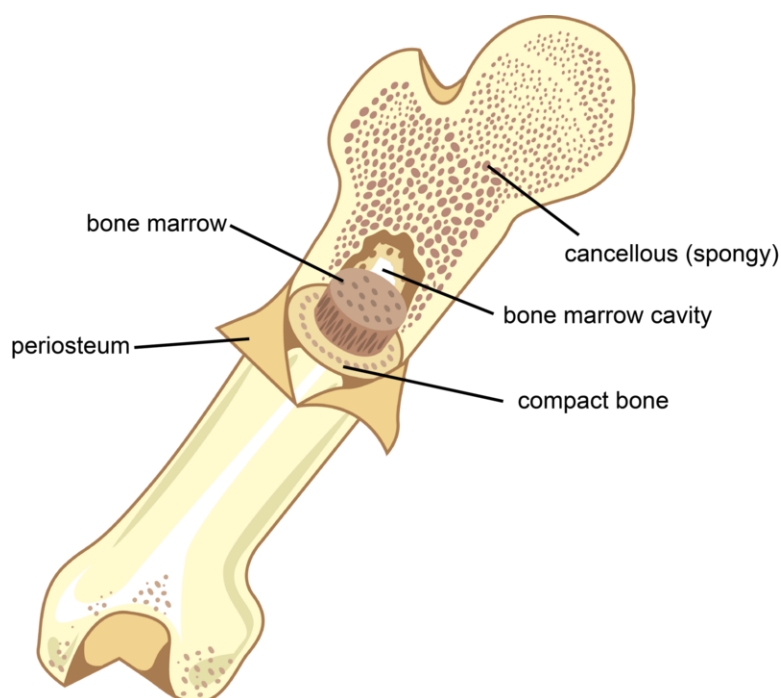
Bones come in four main shapes. They can be long, short, flat, or irregular. Identifying a bone as long, short, flat, or irregular is based on the shape of the bone, not the size of the bone. For example, both small and large bones can be classified as long bones. The small bones in your fingers and the largest bone in your body, the femur, are all long bones. The structure of a long bone is shown in **Figure 1.2**.

**FIGURE 1.1**

The skeletal system is made up of bones, cartilage, and ligaments. The skeletal system has many important functions in your body.

Bone Growth

Your skeleton begins growing very early in development. After only eight weeks of growth from a fertilized egg, your skeleton has been formed by cartilage and other connective tissues.

**FIGURE 1.2**

Bones are made up of different types of tissues.

At this point your skeleton is very flexible. After a few more weeks of growth, the cells that form hard bone begin growing in the cartilage, and your skeleton begins to harden. Not all of the cartilage, however, is replaced by bone. Cartilage remains in many places in your body, including your joints, your rib cage, your ears, and the tip of your nose.

A baby is born with zones of cartilage in its bones that allow growth of the bones. These areas, called growth plate, allow the bones to grow longer as the child grows. By the time the child reaches an age of about 18 to 25 years, all of the cartilage in the growth plate has been replaced by bone. This stops the bone from growing any longer.

Even though bones stop growing in length in early adulthood, they can continue to increase in thickness throughout life. This thickening occurs in response to strain from increased muscle activity and from weight-lifting exercises.

Joints and How They Move

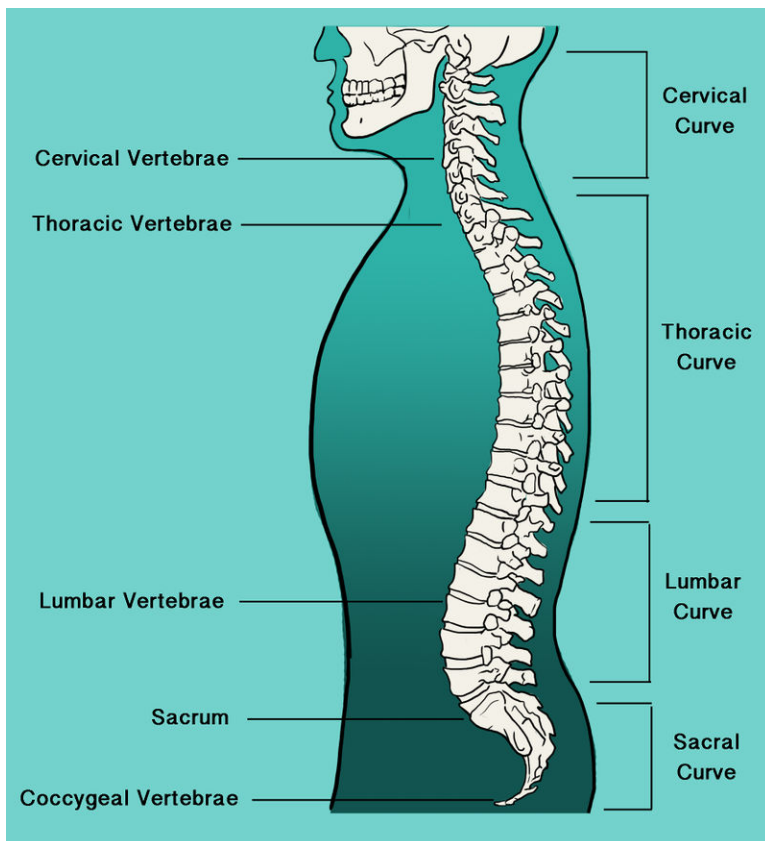
A **joint** is a point at which two or more bones meet. There are three types of joints in the body:

1. Fixed joints do not allow any bone movement. Many of the joints in your skull are fixed (**Figure 1.3**).
2. Partly movable joints allow only a little movement. Your backbone has partly movable joints between the vertebrae (**Figure 1.4**).
3. **Movable joints** allow movement.

Joints are a type of lever, which is a rigid object that is used to increase the amount of force put onto another object. Can openers and scissors are examples of levers. Joints reduce the amount of energy that is spent moving the body around. Just imagine how difficult it would be to walk about if you did not have knees!

**FIGURE 1.3**

The skull has fixed joints. Fixed joints do not allow any movement of the bones, which protects the brain from injury.

**FIGURE 1.4**

The joints between your vertebrae are partially movable.

Movable Joints

Movable joints are the most mobile joints of all. They are also the most common type of joint in your body. Your fingers, toes, hips, elbows, and knees all provide examples movable joints. The surfaces of bones at movable joints are covered with a smooth layer of cartilage. The space between the bones in a movable joint is filled with a liquid called synovial fluid. Synovial fluid is a thick, stringy fluid that looks like egg white. The fluid gives the bone a smooth cushion when they move at the joint. Four types of movable joints are shown below.

1. In a **ball and socket joint**, the ball-shaped surface of one bone fits into the cup-like shape of another. Examples of a ball and socket joint include the hip, shown in **Figure 1.5**, and the shoulder.

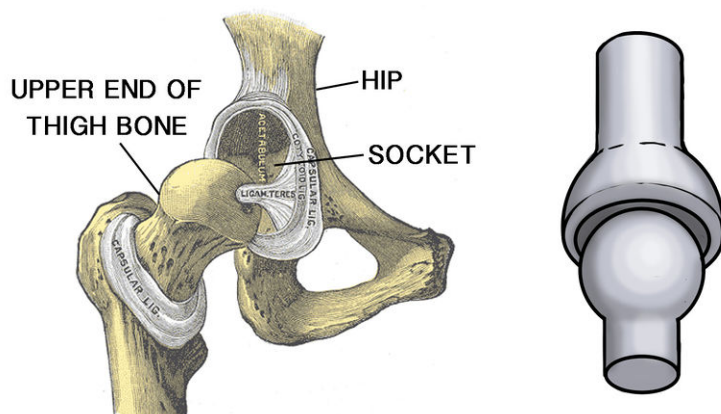


FIGURE 1.5

Ball and Socket Joint. Your hip joint is a ball and socket joint. The “ball” end of one bone fits into the “socket” of another bone. These joints can move in many different directions.

2. In a **hinge joint**, the ends of the bones are shaped in a way that allows motion only in two directions, forward and backward. Examples of hinge joints are the knees and elbows. A knee joint is shown in **Figure 1.6**.

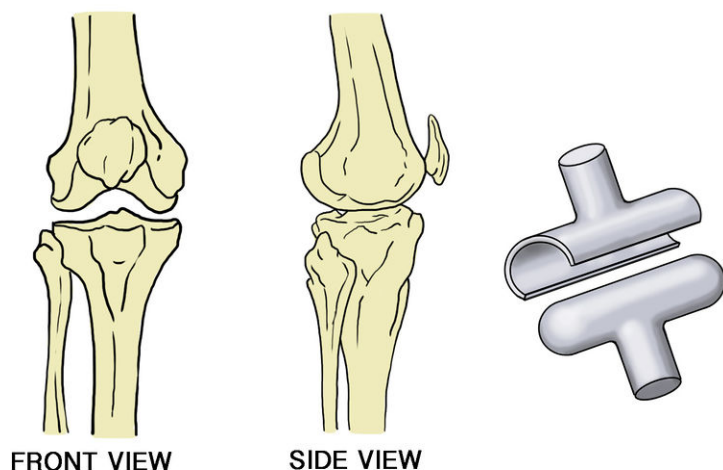


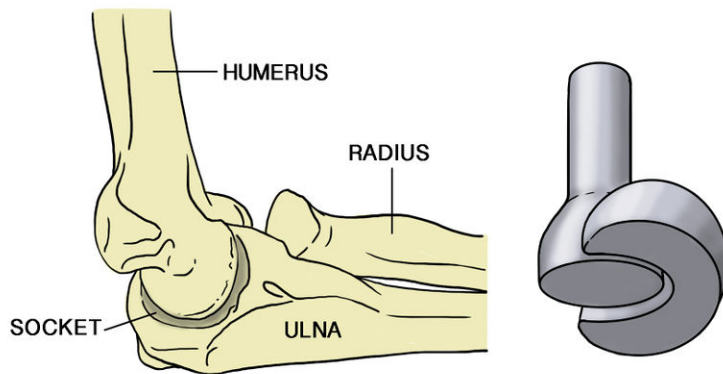
FIGURE 1.6

Hinge Joint. The knee joint is a hinge joint. Like a door hinge, a hinge joint allows backward and forward movement.

3. The **pivot joint** is formed by a process that rotates within a ring, the ring being formed partly of bone and partly of ligament. An example of a pivot joint is the joint between the radius and ulna that allows you to turn the palm of your hand up and down. A pivot joint is shown in **Figure 1.7**.

4. A **gliding joint** is a joint which allows only gliding movement. The gliding joint allows one bone to slide over the

other. The gliding joint in your wrist allows you to flex your wrist. It also allows you to make very small side-to-side motions. There are also gliding joints in your ankles.

**FIGURE 1.7**

Pivot Joint. The joint at which the radius and ulna meet is a pivot joint. Movement at this joint allows you to flip your palm over without moving your elbow joint.

Keeping Bones and Joints Healthy

Your body depends on you to take care of it, just like you may take care of a plant or a dog. You can help keep your bones and skeletal system healthy by eating well and getting enough exercise. Weight-bearing exercises help keep bones strong. Weight-bearing exercises work against gravity. Such activities include basketball, tennis, gymnastics, karate, running, and walking. When the body is exercised regularly by performing weight-bearing activity, bones respond by adding more bone cells to increase their bone density.

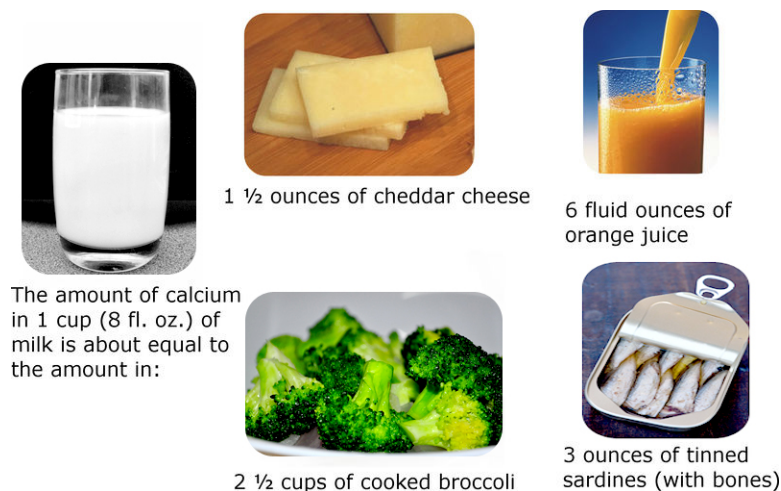
Eating Well

Did you know that what you eat as a teenager can affect how healthy your skeletal system will be in 30, 40, and even 50 years? Calcium and vitamin D are two of the most important nutrients for a healthy skeletal system. Your bones need calcium to grow properly. If you do not get enough calcium in your diet as a teenager, your bones may become weak and break easily later in life.

Osteoporosis is a disease in which bones become lighter and more porous than they should be. Light and porous bones are more likely to break, which can cause pain and prevent a person from walking. Two of the easiest ways to prevent osteoporosis are eating a healthy diet that has the right amount of calcium and vitamin D, and to do some sort of weight-bearing exercise every day. Foods that are a good source of calcium include milk, yogurt, and cheese. Non-dairy sources of calcium include Chinese cabbage, kale, and broccoli. Many fruit juices, fruit drinks, tofu, and cereals have calcium added to them. It is recommended that teenagers get 1300 mg of calcium every day. For example, one cup of milk provides about 300 mg of calcium, or about 30% of the daily requirement. Other sources of calcium are shown in **Figure 1.8**.

Your skin makes vitamin D when exposed to sunlight. The pigment melanin in the skin acts like a filter that can prevent the skin from making vitamin D. As a result, people with darker skin need more time in the sun than people with lighter skin to make the same amount of vitamin D.

Fish is naturally rich in vitamin D. Vitamin D is added to other foods, including milk, soy milk, and breakfast cereals. Teenagers are recommended to get 5 micrograms (200 IU) of vitamin D every day. A $3\frac{1}{2}$ -ounce portion of cooked salmon provides 360 IU of vitamin D.

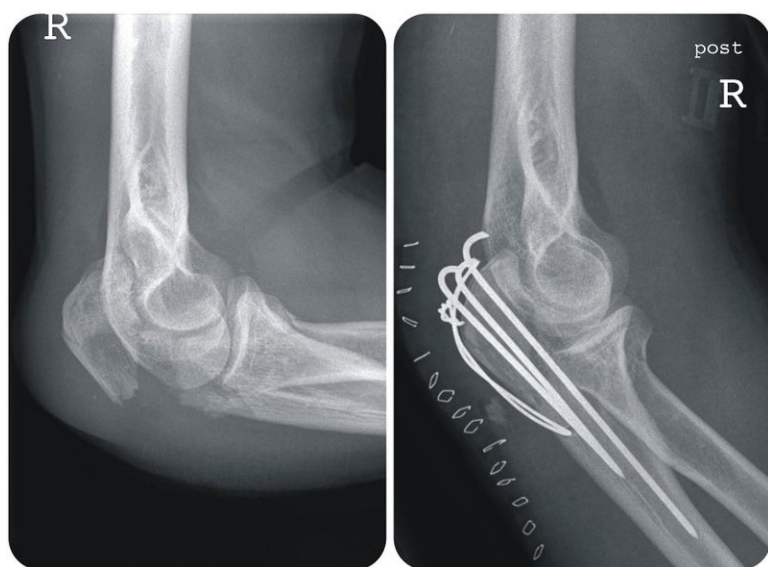
**FIGURE 1.8**

There are many different sources of calcium. Getting enough calcium in your daily diet is important for good bone health. How many ounces of cheddar cheese would provide your recommended daily intake of calcium?

Bone Fractures

Even though they are very strong, bones can **fracture**, or break. Fractures can happen at different places on a bone. They are usually caused by excess bending stress on the bone. Bending stress is what causes a pencil to break if you bend it too far.

Soon after a fracture, the body begins to repair the break. The area becomes swollen and sore. Within a few days bone cells travel to the break site and begin to rebuild the bone. It takes about two to three months before compact and spongy bone form at the break site. Sometimes the body needs extra help in repairing a broken bone. In such a case a surgeon will piece a broken bone together with metal pins. Moving the broken pieces together will help keep the bone from moving, and give the body a chance to repair the break. A broken ulna has been repaired with pins in **Figure 1.9**.

**FIGURE 1.9**

The upper part of the ulna, just above the elbow joint, is broken, as you can see in the X-ray at left. The X-ray at right was taken after a surgeon inserted a system of pins and wires across the fracture to bring the two pieces of the ulna into close proximity.

Cartilage Injuries

Osteoarthritis occurs when the cartilage at the ends of the bones breaks down. The break down of the cartilage leads to pain and stiffness in the joint. Decreased movement of the joint because of the pain may lead to weakening of the muscles that normally move the joint, and the ligaments surrounding the joint may become looser. Osteoarthritis is the most common form of arthritis. It has many causes, including aging, sport injuries, fractures, and obesity.

Ligament Injuries

Recall that a ligament is a short band of tough connective tissue that connects bones together to form a joint. Ligaments can get injured when a joint gets twisted or bends too far. The protein fibers that make up a ligament can get strained or torn, causing swelling and pain. Injuries to ligaments are called **sprains**. Ankle sprains are a common type of sprain. A sprain of the anterior cruciform ligament (ACL), a small ligament in the knee, is a common injury among athletes. Ligament injuries can take a long time to heal. Treatment of the injury includes rest and special exercises that are developed by a physical therapist.

Preventing Injuries

Preventing injuries to your bones and ligaments is easier and much less painful than treating an injury. Wearing the correct safety equipment when performing activities that require such equipment can help prevent many common injuries. For example, wearing a bicycle helmet can help prevent a skull injury if you fall. Warming up and cooling down properly can help prevent ligament and muscle injuries. Stretching before and after activity also helps prevent injuries. Stretching can improve your posture, and helps prevent some aches and pains associated with tight muscles.

Lesson Summary

- Bones, cartilage, and ligaments make up the skeletal system.
- The skeleton supports the body against the pull of gravity.
- The skeleton provides a framework that supports and protects the soft organs of the body.
- Bones work together with muscles to move the body.
- Blood cells are mostly made inside the bone marrow.
- There are three types of joints in the body: fixed, partly movable, and movable.
- Calcium and vitamin D are two of the most important nutrients for a healthy skeletal system.
- The break down of the cartilage leads to pain and stiffness in the joint.
- A sprain is an injury to a ligament.
- A fracture is a break or crack in a bone.

Review Questions

Recall

1. What are the main organs of the skeletal system?
2. Name one tissue of the skeletal system.
3. List four functions of the skeletal system.
4. Name three types of movable joints.

5. Name two things you can do to keep your skeletal system healthy.

Apply Concepts

6. “All joints in the body are movable.” Do you agree with this statement? Explain why or why not.
7. How are the joints in your body similar to levers?
8. Why is calcium important for a healthy skeletal system?
9. The recommended daily amount of calcium for teenagers is 1300 mg. If a person gets only 1000 mg a day, what percentage of the recommended daily amount are they getting?
10. What part of the skeletal system does osteoarthritis affect?
11. Why might a doctor need to insert pins into a broken bone?

Critical Thinking

12. You are a doctor. An athlete comes to you with a torn ACL and asks you to give him a cast. Tell him why that is not the correct treatment for his injury.

Further Reading / Supplemental Links

- <http://www.girlshealth.gov/bones>
- http://www.cdc.gov/nccdphp/dnpa/nutrition/nutrition_for_everyone/basics/calcium.htm

Points to Consider

Next we discuss the muscular system.

- How do you think your skeletal system interacts with your muscular system?
- How could a broken bone affect the functioning of the muscular system?

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