

Bone Structure and Growth

by Sophia



WHAT'S COVERED

In this lesson you will learn the fundamentals of bone structure and growth. Specifically, this lesson will cover:

1. Bone Structure

Bones are the basic building blocks of the skeletal system. A bone is a connective tissue of cells and fibers. We'll start with the cells that make up bones and work our way up in size to the gross anatomy of bones.

There are three types of cells that are important in bone growth and bone structure.

- **Osteoblasts:** This type of bone cell is found in the second layer of the **periosteum** and is responsible for building bone. An osteoblast builds bone tissue by secreting proteins, including collagen fibers that bind to calcium; this combination forms the tough tissue matrix of bone. The area around it will mineralize (requiring calcium); when mineralized, it becomes an osteocyte.
- **Osteocytes:** This type of bone cell matures from osteoblasts that have surrounded themselves with the collagen fibers they've secreted. Once the collagen fibers have mineralized with calcium, the osteocytes have crowded themselves in and will no longer form bone matrix.
- **Osteoclasts:** This type of bone cell breaks down bone tissue by secreting hydrochloric acid into the tissue spaces, dissolving the bond between calcium and collagen.



TERMS TO KNOW

Bone

A connective tissue of cells and fibers covered by a membrane called the periosteum.

Osteoblast

A cell that builds bone tissue by secreting collagen fibers that bind to calcium; this combination forms the tough tissue matrix of bone.

Periosteum

A two-layered connective tissue that is found on the outside of all bones; supports, nourishes, and protects bones of the body.

Osteocyte

A bone cell that is formed when an osteoblast becomes embedded in the matrix it has secreted

and the matrix is mineralized.

Osteoclast

A cell that breaks down bone tissue by secreting hydrochloric acid into the tissue spaces; dissolves the bond between calcium and collagen.

2. Bone Remodeling

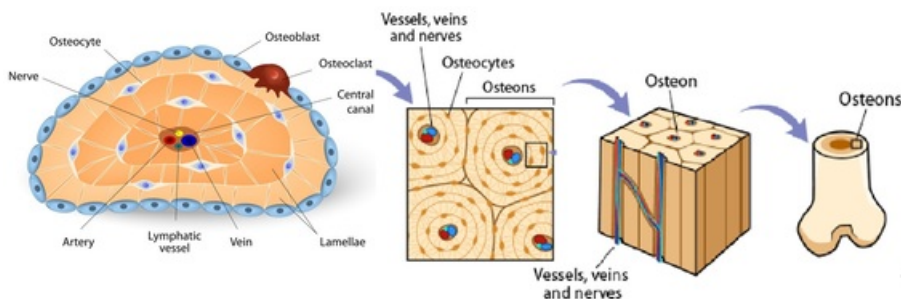
We have cells that build bone and cells that break down bone. Both these types of bone cells are important for a process called bone remodeling.

Bone remodeling allows your body to maintain calcium levels; you need certain levels of calcium in your blood. If calcium levels in your blood are too low, osteoclasts will break down bone and release calcium into the blood. Osteoblasts will help build bone if there's excess calcium in the blood. This helps keep bones resilient.

You can think of bone remodeling as preventative maintenance. Your car's oil, brakes, tires, etc. wear out over time—instead of waiting until something expensive breaks, you have scheduled replacements. In the same way, osteoclasts break down older bone tissue so the osteoblasts can replace it with new tissue.}}

3. Bone Function

As you can see from the picture below, osteoblasts, osteoclasts, and osteocytes form long, cylindrical structures called **osteons**.



The osteon is the functional unit of bone. It is cylindrical in nature and contains a hollow central canal (Haversian canal) that is surrounded by bone cells (osteocytes). This hollow canal provides room for blood vessels and nerves. Blood vessels will carry substances to and from osteocytes.



THINK ABOUT IT

You can think of osteons like drinking straws filled with blood vessels and nerves, so your bones are a bit like a bundle of straws wrapped together. If you stand one straw up by itself, it's kind of flimsy. But if you wrap a bunch of straws together, stand them up and set a textbook on top of them, you see how strong a bunch of little cylinders can be!



TERM TO KNOW

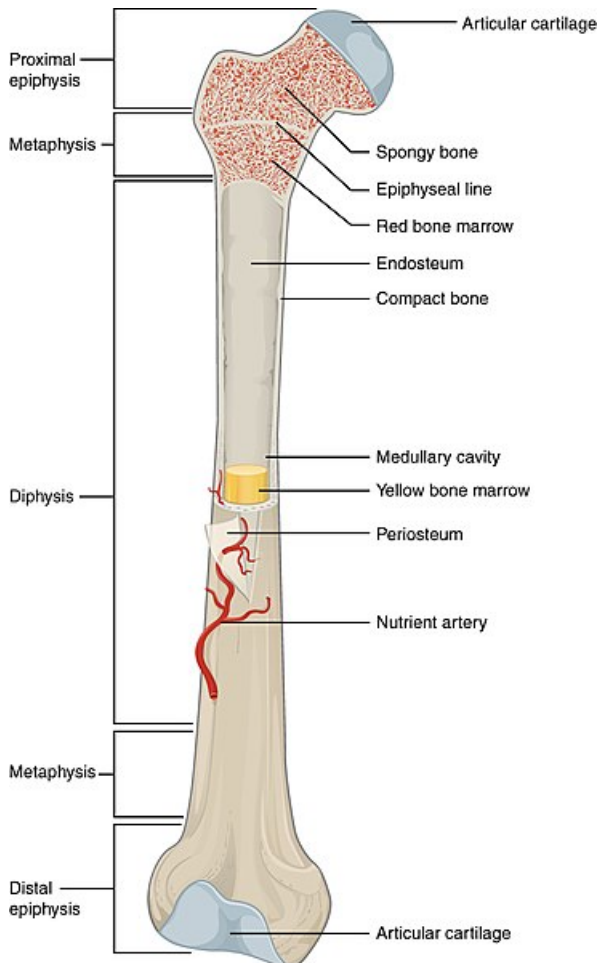
Osteon

The functional unit of bone, is circular in nature, and contains a hollow central canal (Haversian

canal) that is surrounded by bone cells (osteocytes).

4. Bone Tissue

There are two types of bone tissue: Compact and spongy.



4a. Compact Bone

Compact bone is formed by osteons and makes up the hard exterior of all bones.

In long bones, like the femur, compact bone surrounds yellow **bone marrow**. In adults, most bone marrow is yellow bone marrow, which serves as fat storage.



TERMS TO KNOW

Compact Bone

A type of bone tissue that consists of many osteons and a dense tissue matrix; cells of the osteons surround central canals called Haversian canals; found in the shafts of long bones and periphery of spongy bone.

Bone Marrow

A substance that is found within the hollow areas of bone; red marrow is found within the spongy bones and yellow marrow is found in the shaft (diaphysis) of long bones.

4b. Spongy Bone

Besides compact bone, the other major type of bone tissue is **spongy bone**. Spongy bone is thin beams of osteocytes that form a hard matrix which looks like a sponge under a microscope. Spongy bones are found in the ends of long bones and within flat bones. Spongy bone is porous and lighter in weight but more flexible.

Spongy bone is usually located near the ends of long bones, also known as the **epiphysis**. In some cases, this is where red bone marrow is located. Red bone marrow produces red blood cells and white blood cells, but most adults do not have a lot of red bone marrow. Red bone marrow can also be found in a few flat bones within your body, such as your shoulder blades and ribs.



THINK ABOUT IT

Question: If you don't have a lot of red bone marrow and you were in some sort of accident, how would your body compensate for major blood loss?

Answer: Your bone marrow would need to produce more red blood cells to replace the blood that you've lost. Yellow bone marrow can actually convert back to red bone marrow if necessary.



BIG IDEA

The periosteum is the two-layer membrane found on the outside of the bone. Inside the bone, there are two different types of bone tissue—spongy bone and compact bone. The bone shaft is the center part of the bone where both yellow and red bone marrow are found.



TERMS TO KNOW

Spongy Bone

Thin beams of compact bone that are found in the ends of long bones and joints; is porous and lighter in weight.

Epiphysis

Enlarged ends of long bones that contain spongy bone and yellow bone marrow, except the head of the humerus and femur (contain red marrow).

5. Bone Growth and Development

The **cartilage model** is the model that is used to describe how bone is manufactured from embryonic cartilage. Over time, the **cartilage** that composes bone will be turned into actual bone by osteoblasts. The building of bone starts from the middle of the bone and works its way outward.

The epiphyseal plate is a part of the bone that's made of cartilage and separates the shaft from the epiphysis. The epiphysis is the enlarged end of long bones that contains spongy bone and yellow bone marrow. The exceptions are the head of the humerus and femur, which contain red marrow.

A bone of a developing embryo will be made of cartilage. Then the osteoblasts are going to become active. They will form a bony collar, and then the bone will start to mineralize. From there, it will grow outwards. Blood vessels will start to invade, more bone tissue will form, and the bone remodeling will continue to take place—building more bone from the middle outwards. Then secondary bone-forming centers will appear at the end.

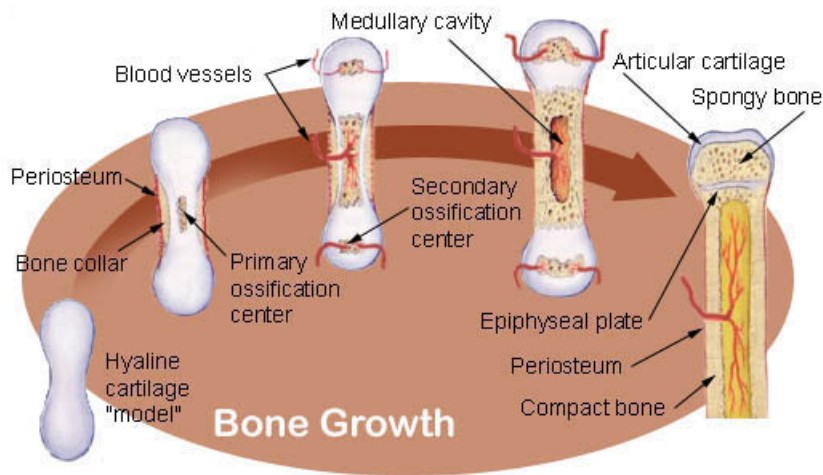


DID YOU KNOW

The human growth hormone, HGH, prevents the epiphyseal plate from calcifying until the person is done

growing.

This diagram shows how a bone develops over time.



TERMS TO KNOW

Cartilage Model

The model that is used to describe how bone is manufactured from embryonic cartilage.

Cartilage

A tough, flexible, whitish connective tissue (also known as "gristle"); gives shape to the ear and nose tip; provides cushion between many joints.



SUMMARY

The **structure of bone** includes several different components. There are three major types of bone cells: Osteoblasts (which build bone), osteoclasts (which break down bone), and osteocytes (mature osteoblasts which give structure to osteons). Osteons are the functional unit of compact bones, forming "drinking straws" of hard tissue surrounding blood vessels and nerves. Inside the bone are spongy bone and compact bone tissue. Bone also contains bone marrow, both yellow and red. Yellow bone marrow serves as fat storage and can convert to red bone marrow when needed. Red bone marrow produces red and white blood cells. Bone is covered and protected by a membrane called the periosteum. The **function of bone** is to give support and protection to our bodies and organs.

The cartilage model describes the process of **bone growth and development**. Bones begin as cartilage. The bone-forming areas at the ends work their way out from the middle of the bone. The epiphyseal plate is the cartilage plate that separates the epiphysis (the end of the bone) from the shaft. Keep up the learning and have a great day!

Source: THIS WORK IS ADAPTED FROM SOPHIA AUTHOR AMANDA SODERLIND



ATTRIBUTIONS

- [Spongy and Compact Bone](#) | Author: Wikipedia | License: Creative Commons
- [Bone Growth](#) | Author: Wikipedia | License: Public Domain



TERMS TO KNOW

Bone

A connective tissue of cells and fibers covered by a membrane called the periosteum.

Bone Marrow

A substance that is found within the hollow areas of bone; red marrow is found within the spongy bones and yellow marrow is found in the shaft (diaphysis) of long bones.

Cartilage

A tough, flexible, whitish connective tissue (also known as "gristle"); gives shape to the ear and nose tip; provides cushion between many joints.

Cartilage Model

The model that is used to describe how bone is manufactured from embryonic cartilage.

Compact Bone

A type of bone tissue that consists of many osteons and a dense tissue matrix; cells of the osteons surround central canals called Haversian canals; found in the shafts of long bones and periphery of spongy bone.

Epiphysis

Enlarged ends of long bones that contains spongy bone and yellow bone marrow, except the head of the humerus and femur (contains red marrow).

Osteoblast

A cell that builds bone tissue by secreting collagen fibers that bind to calcium; this combination forms the tough tissue matrix of bone.

Osteoclast

A cell that breaks down bone tissue by secreting hydrochloric acid into the tissue spaces; dissolves the bond between calcium and collagen.

Osteocyte

A bone cell that is formed when an osteoblast becomes embedded in the matrix it has secreted and the matrix is mineralized.

Osteon

The functional unit of bone, is circular in nature, and contains a hollow central canal (Haversian canal) that is surrounded by bone cells (osteocytes).

Periosteum

A two-layered connective tissue that is found on the outside of all bones; supports, nourishes, and protects bones of the body.

Spongy Bone

Thin beams of compact bone that are found in the ends of long bones and the middle of spongy bone; is porous and lighter in weight.

