Bone Structure and Physiology

Figure XX illustrates a typical bone. The joint surface is covered with a layer of cartilage. Beneath the cartilage is a spongy tissue known as cancellous bone. The superficial layer consists of compact bone.

The outer surface of the bone is covered by a specialized connective tissue called periosteum. Cortical bone surrounds the center cavity, which contains marrow and is known as the medullary cavity. The internal surface is covered by endosteum, which lines the medullary cavity.

Viewed microscopically, compact bone consists of a great number of circular areas, each of which was formed at a different time. These areas are the structural units of compact bone. Each structural unit is known as an osteon, which consists of a haversian canal and concentric lamella. The haversian canal contains blood vessels and nerve tissue. It interconnects with smaller canals, known as canaliculi, and with spaces known as lacunae. Blood vessels in the network of canals carry nutrient materials to bone tissue and carry away waste material. As is explained below, they also carry calcium and phosphorous to and from bone tissue and the general circulation.

Cortical and cancellous bone are constantly being modified, in a process known as remodeling. In this process, old bone is replaced with new bone, and bone structure changes somewhat to accommodate the stresses of locomotion and gravity.

Remodeling involves two phases: bone resorption and bone formation. These phases occur in three specific and distinct areas, called envelopes: the periosteal envelope, the haversian envelope, and the endosteal envelope.

cartilage: a dense, specialized connective tissue that can withstand considerable pressure

compact bone: hard or dense bone that forms the superficial layer of all bones

periosteum: a fibrous membrane that covers bone, except at the joint surface

cortical bone: compact bone surrounding the center cavity

medullary cavity: the soft tissue center of a bone, consisting of bone marrow

endosteum: the membrane that lines the medullary cavity

osteon: the basic structural unit of compact bone

haversian canal: a minute tunnel in bone tissue

lamella (pl., lamellae): a thin layer of bone tissue

lacuna (pl., lacunae): a small hollow space in bone tissue

remodelling: a continuous process in which old bone is absorbed and new bone is deposited

resorption: the act of removal by absorption

In remodeling, cells known as osteoblasts form new bone, and cells known as osteoclasts resorb old bone. These two events occur in sequence. A single basic multicellular unit (BMU), also known as a bone remodeling unit (BRU), forms a single new bone structural unit (BSU). Normally bone resorption and formation are in equilibrium, except in growing bones, where formation far outpaces resorption. Figure XX illustrates the remodeling sequence as it occurs in a haversian envelope.

1. The quiescent surface is covered with lining cells.

2. Activated osteoclasts begin the resorption process, eating away at the bone tissue.

3. In the reversal phase, cells of unknown origin deposit a cement substance (the cement line).

4. In the early formation stage, osteoblasts secrete a layer of osteoid on the cement line.

5. In the late formation stage, osteoid formation is almost complete and a layer of new mineralized bone is visible.

6. The remodeling phase is over and the quiescent surface is again covered with lining cells. The area that was eroded by osteoclasts has been filled in with a new bone structural unit.

Remodeling is a gradual process. Over several weeks, small groups of osteoclasts erode bone tissue, forming a tunnel. Over several months, osteoblasts enter the tunnel and form new bone. The new bone is laid down concentrically until the tunnel is filled. When osteoblasts close in on the blood vessels that supply the area, they stop depositing bone. The section of the tunnel

that remains is the haversian canal, through which the blood vessels run.