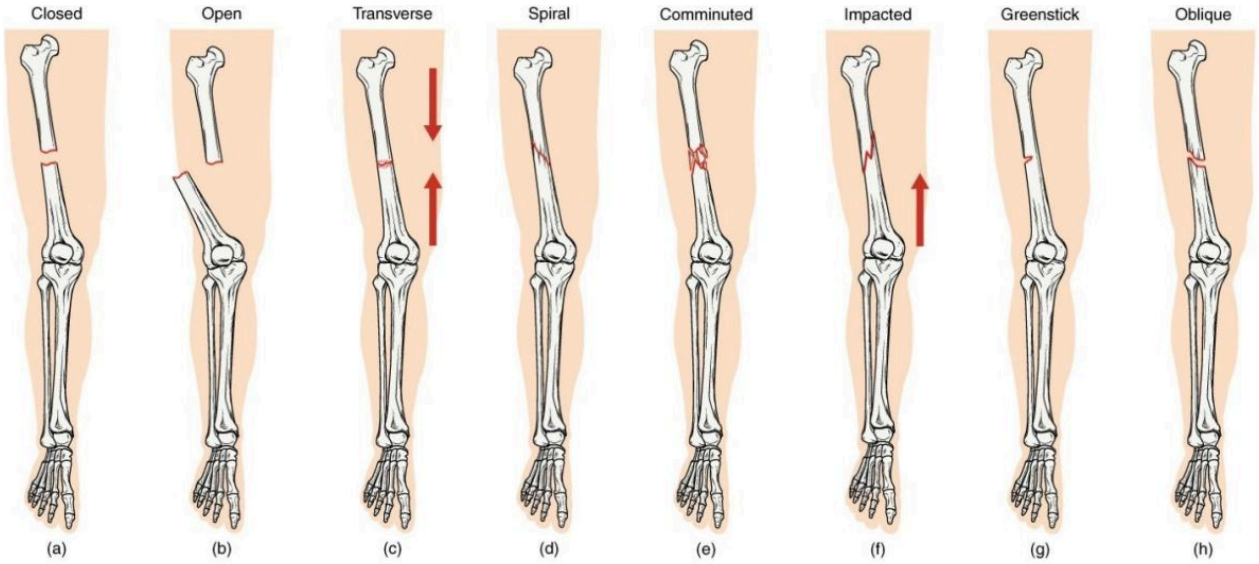
6.2.4

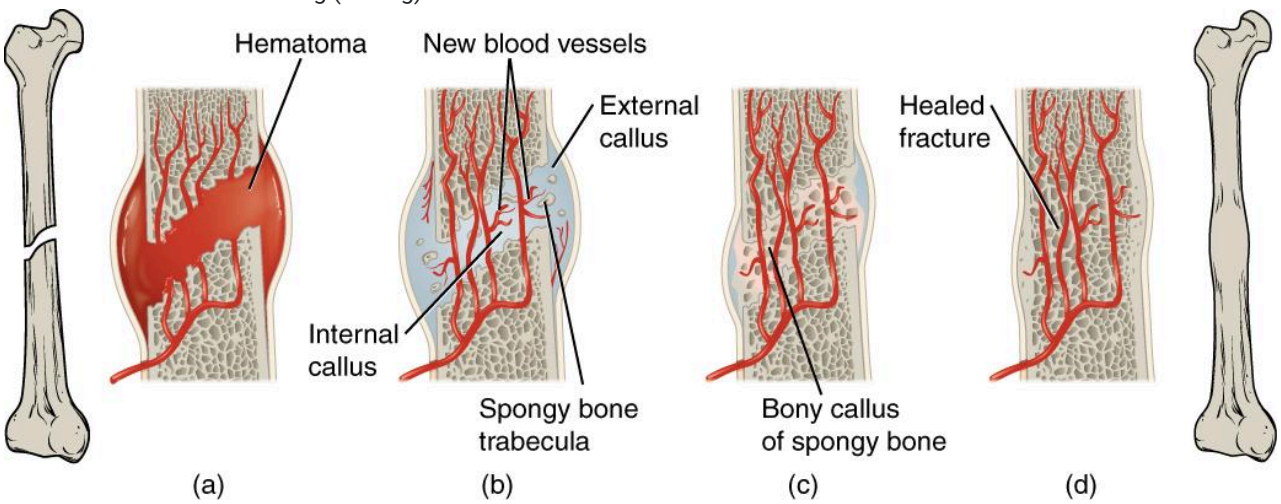
Bone Repair

What happens when a bone is fractured? Fractures are classified by the type and location of the break. See the image below:



Types of Fractures. *By OpenStax College [CC BY 4.0 (http://creativecommons.org/licenses/by/4.0)], via Wikimedia Commons. Link: https://upload.wikimedia.org/wikipedia/commons/3/35/612_Types_of_Fractures.jpg*

Repair of fractures occurs in four major stages, assuming that the bones have been somewhat realigned. Realigning of the bone is known as reducing (setting) the fracture.



Stages of Bone Repair. *By OpenStax College License: CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons Link: https://upload.wikimedia.org/wikipedia/commons/1/12/613_Stages_of_Fracture_Repair.jpg*

1. Hematoma Forms: Stage 1 involves the formation of a hematoma, a mass of clotted blood that forms within a few hours after injury. This is caused by rupture of the associated blood vessels in the bone and in the tissues surrounding the bone, recall that bone is highly vascular. The hematoma is fragile and can be easily damaged, this is why broken bones are immobilized by casts or boots while they are healing.
2. Bone Generation: External Callus and Internal Callus Form: In the next stage of repair, over several days, blood vessels grow into the hematoma bringing macrophages, and stem cells that can differentiate into the various bone and cartilage cells. During the next few weeks, an external callus forms around the fracture to encircle the bone like a collar to stabilize the fracture. Then, an internal callus is formed as a network of spongy bone to unite the inner surfaces of the bone. The macrophages clean up the cellular debris as osteoclasts break down the fragments of dead bone.
3. Boney Callous: Fibroblasts and chondroblasts then form a fibrocartilage callus that can be used as a model for formation of new bone. Once the fibrocartilage callus is formed the osteoblasts begin to convert the fibrocartilage callus to bone. Over a period of about 8 weeks, the third stage of repair is complete and results in the formation of a bony callus.
4. Bone Remodeling: The newly formed bone is woven bone, which is remodeled into lamellar bone by the osteoclasts and osteoblasts in the final stage of repair. The remodeling phase takes several months to a few years to complete. This remodeling also hollows out the medullary cavity and returns the bone to its original shape.

The healing process described above is known as indirect healing. Another type of healing can occur if the broken ends of the bone are precisely and rigidly held in place. This type of healing (direct healing) typically takes place only in the bones that have been surgically realigned and held tightly in place, usually with metal plates and screws. With this type of healing, new, lamellar bone forms directly, without the development of the callus.