

# Pathology Team

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الأحمر هو ما ركزت عليه  
الدكتور



*Bone Pathology : Fractures &  
Healing*

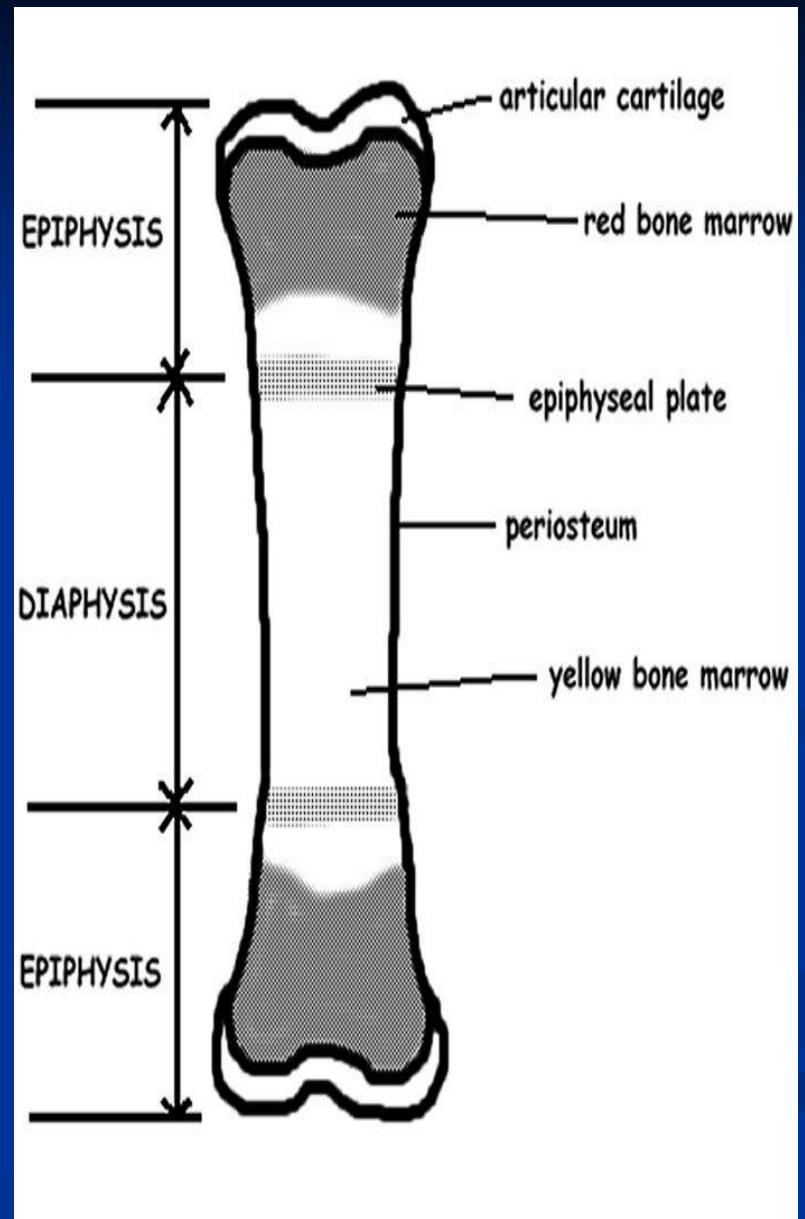
# Healing of bone fractures

- At the end of this lecture you should :
  - Know the different types of fractures
  - Be aware of the mechanism and stages of fracture healing process
  - Know the factors affecting healing process and the possible complications of healing process
  - Appreciate the importance of road traffic accidents as a major cause of disability in Saudi Arabia

# Normal anatomy

## ■ Parts of a long bones:

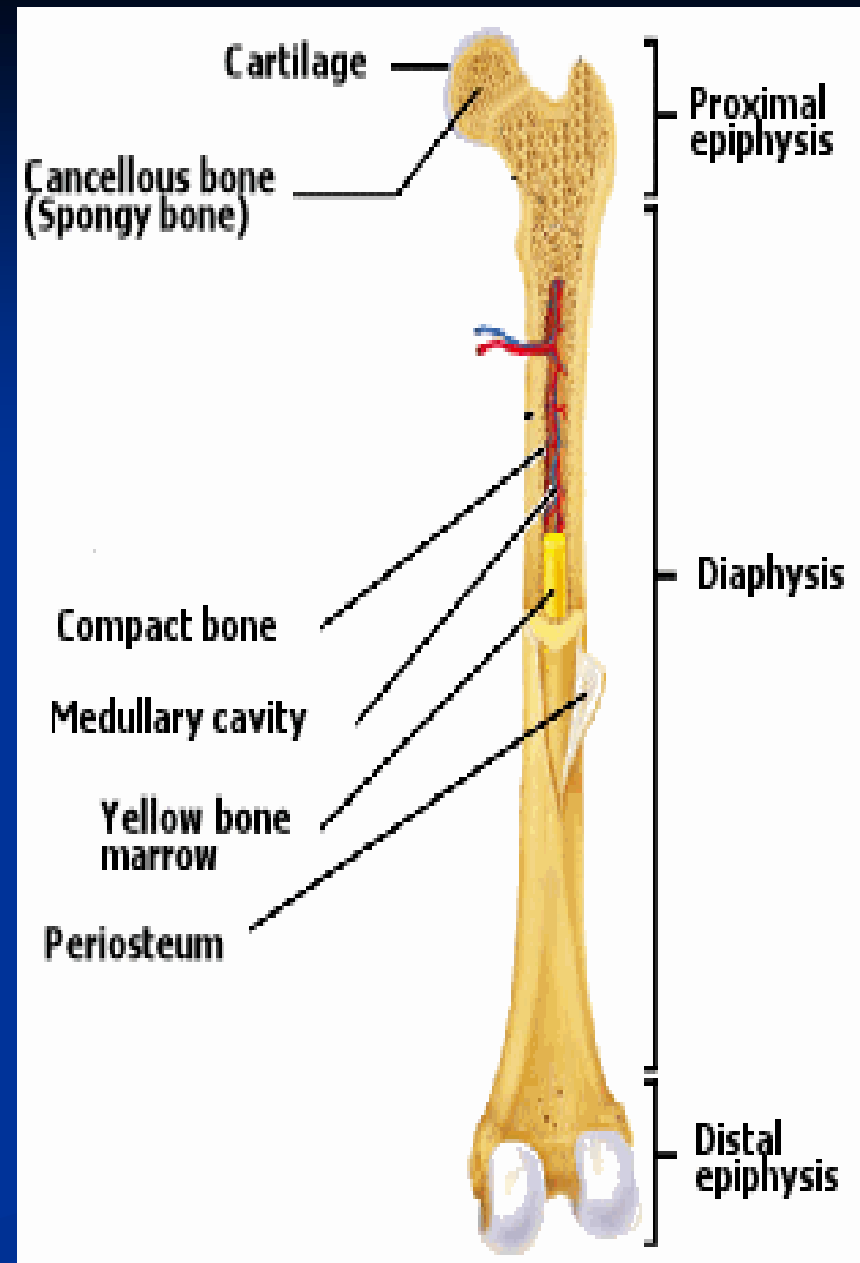
- epiphysis (ends of bone, partially covered by articular cartilage)
- physis (growth plate)
- metaphysis (junction of diaphysis and epiphysis, most common site of primary bone tumors)
- diaphysis (shaft)



# Normal anatomy

## ■ Cross section:

- Periosteum
- cortex (composed of cortical bone or compact bone)
- medullary space (composed of cancellous or spongy bone)



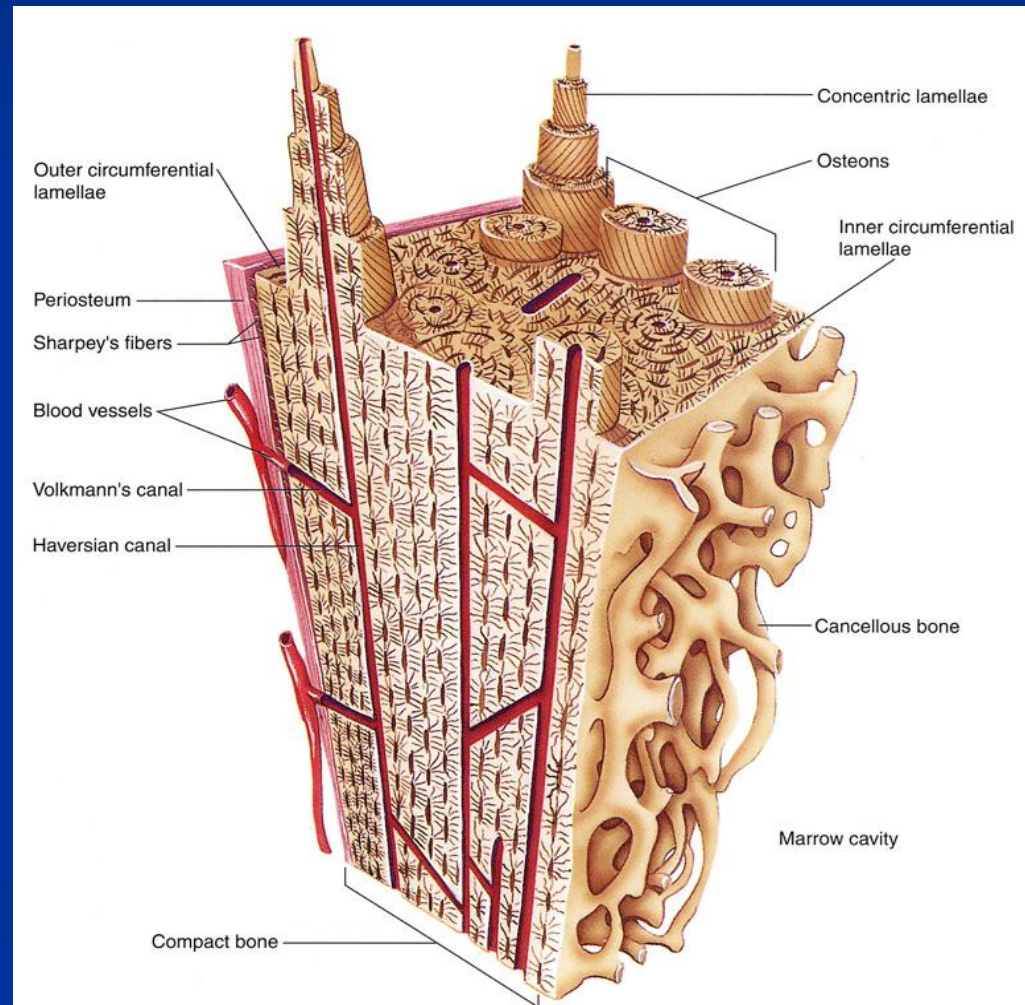


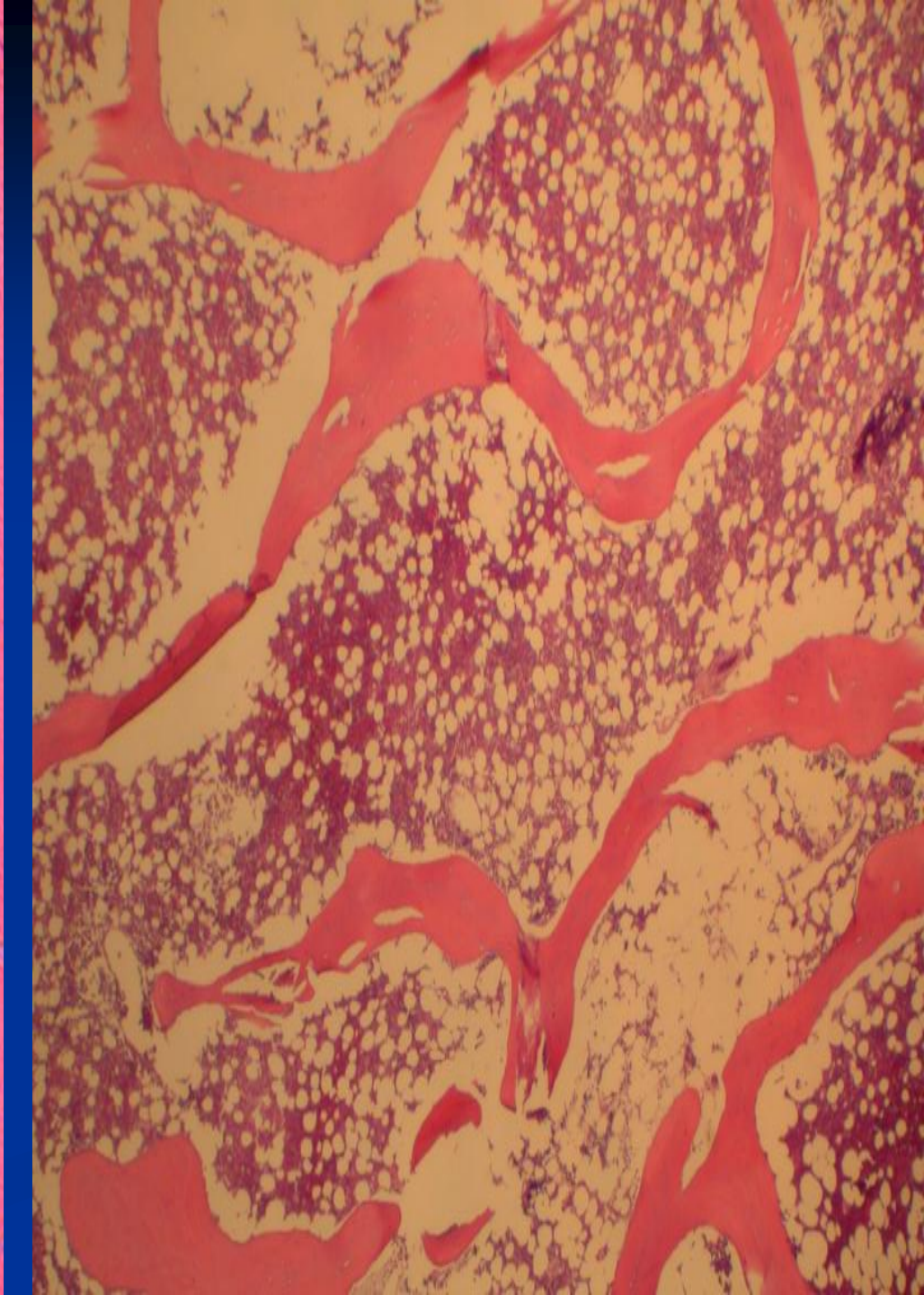
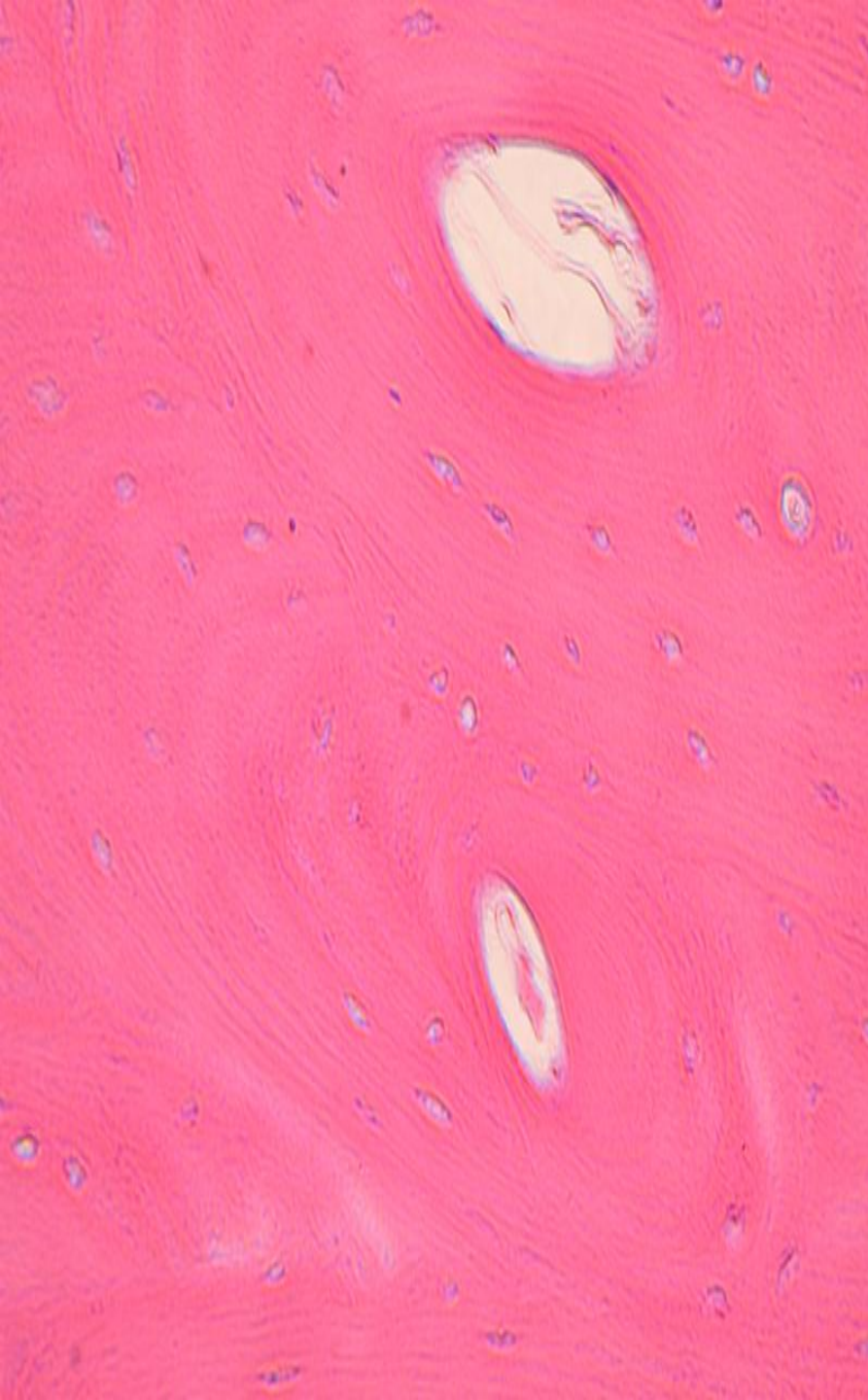
# Normal histology

**Bone:** mineralized osteoid; either lamellar bone or woven bone.

## ■ Lamellar bone:

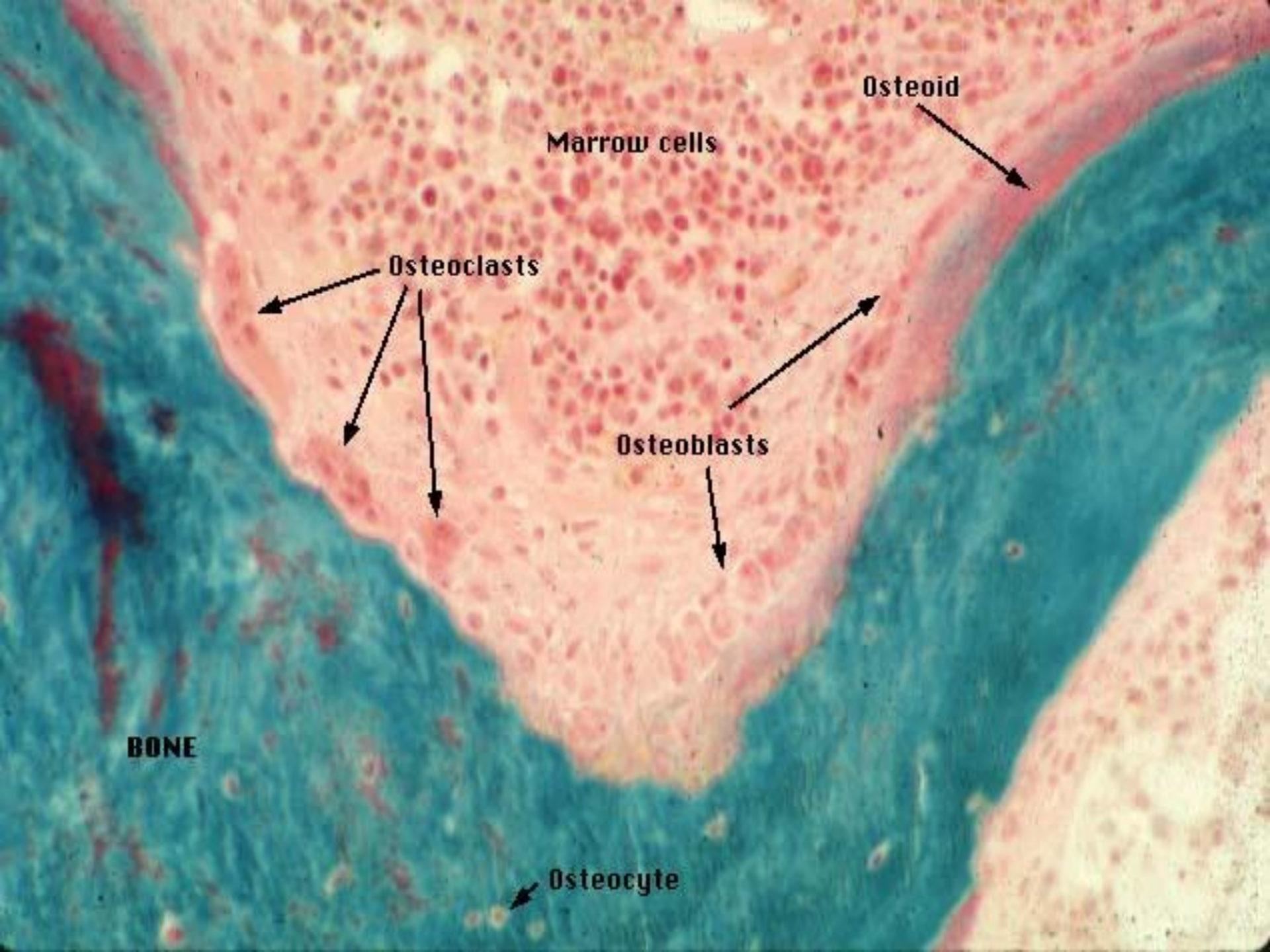
- layered bone with concentric parallel lamellae
- gradually replaces woven bone
- normal type of bone found in adult skeleton
- stronger than woven bone





- **Osteoblasts:** arise from marrow mesenchymal cells; when active, are plump and present on bone surface; eventually are encased within the collagen they produce.
- **Osteoclasts:** large multinucleated cells found attached to the bone surface at sites of active bone resorption.
- Osteoblast: present on the surface , produce collagen
- Osteoclast: attached to the bone surface (resorption)





Osteoid

Marrow cells

Osteoclasts

Osteoblasts

BONE

Osteocyte

# Classification of fractures

Classification of fractures is important for different treatment

- Complete or incomplete

Incomplete fracture : partial fracture

Complete fracture : through the whole horizontal section of the bone

- Closed or compound

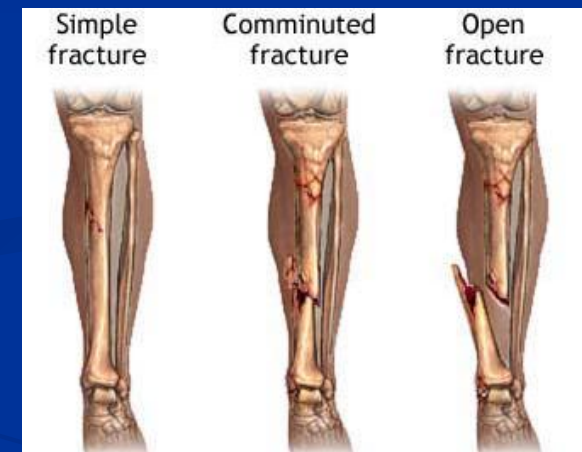
Compound (open fracture) < there's a rupture on the over laying skin

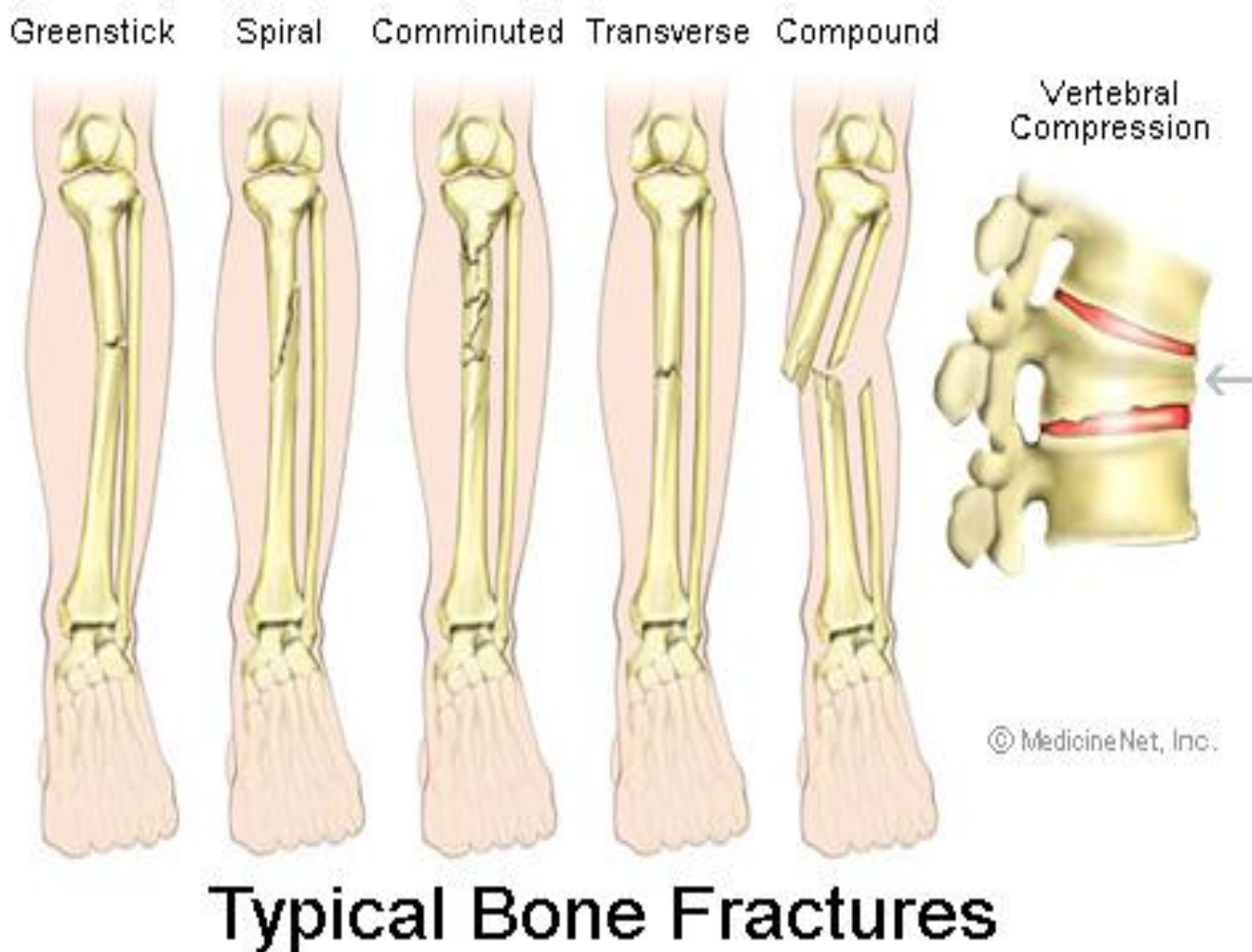
- Comminuted

Comminuted = severe = fragmented < hard to treat

- Displaced

Displaced = change in the bone alignment





- Greenstick = common in children , easy in healing
  - Vertebral compression : there's a pressure on the vertebrae and there's osteoporosis
- Traumatic fracture is the most common

# Classification of fractures

- Traumatic fracture: Sever trauma
- Pathological fracture:
  - Fracture occur with minimal trauma
  - the underlying bone is abnormal e.g.
    - Osteoporosis
    - Osteomalacia due to Vitamine D deficiency
    - Paget's disease of bone (rare)
    - Primary or metastatic tumor.
- Stress fracture

Stress fracture is usually in small bones ,  
common in soldiers (because they hit the  
ground hard)



# Stress fracture

A stress fracture is generally an overuse injury. It occurs when muscles become fatigued or overloaded and can not absorb the stress and shock and repeated impact. Fatigued muscles transfer that stress to the nearby bone and the result is a small crack or fracture, in the bone.



# Healing of fractures

## 1. Reactive Phase

- i Fracture and inflammatory phase
- ii. Granulation tissue formation

## 2. Reparative Phase

- iii. Callus formation
- iv. Lamellar bone deposition

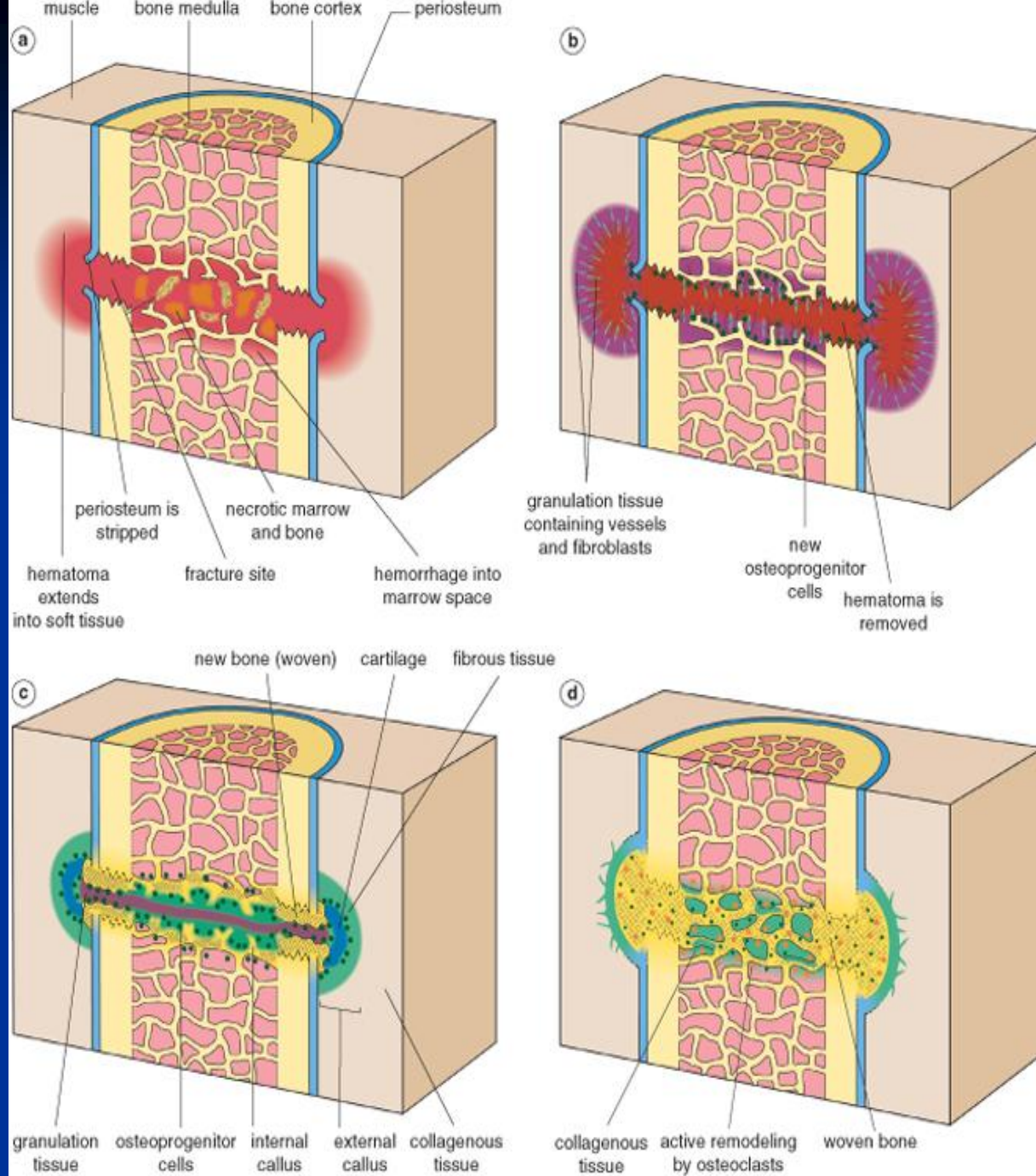
## 3. Remodeling Phase

- v. Remodeling to original bone contour

## ■ *How does a fracture heal?*

### Stage 1: Inflammation

Bleeding from the fractured bone and surrounding tissue causes the fractured area to swell. This stage begins the day you fracture the bone and lasts about 2 to 3 weeks.





# Reparative Phase

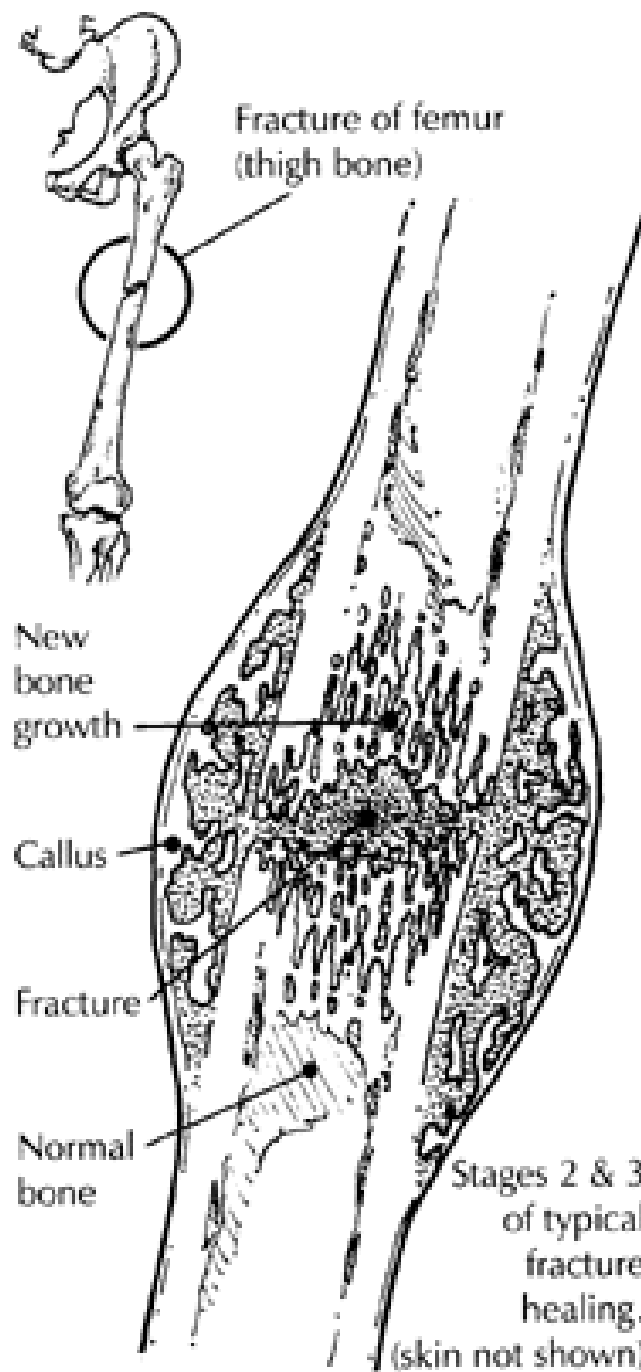
Callus is not only in the bone , it also occurs in the surrounding areas

## ■ Soft callus

Between 2 and 3 weeks after the injury, the pain and swelling will decrease. At this point, the site of the fracture stiffens and new bone begins to form (see figure). The new bone cannot be seen on x-rays. This stage usually lasts until 4 to 8 weeks after the injury.

## ■ Hard callus

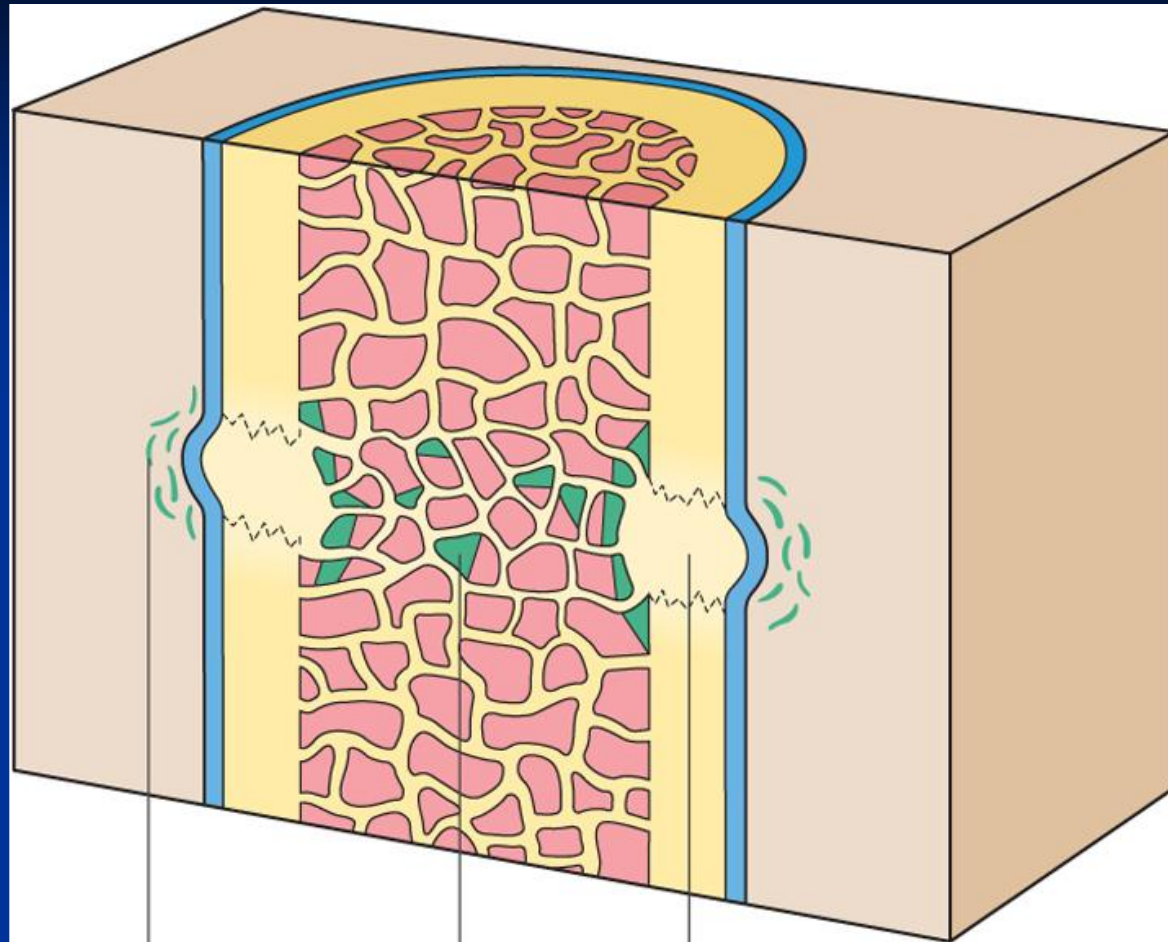
Between 4 and 8 weeks, the new bone begins to bridge the fracture. This bony bridge can be seen on xrays. By 8 to 12 weeks after the injury, new bone has filled the fracture.



- Bone remodeling

Beginning about 8 to 12 weeks after the injury, the fracture site remodels itself, correcting any deformities that may remain as a result of the injury. This final stage of fracture healing can last up to several years.

- The rate of healing and the ability to remodel a fractured bone vary tremendously for each person and depend on your age, your health, the kind of fracture, and the bone involved. For example, children are able to heal and remodel their fractures much faster than adults.



residual scar  
in muscle

remodeling of  
medulla with some  
residual fibrosis

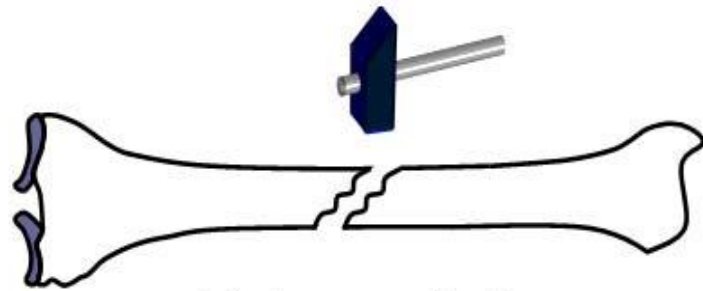
cortex replaced by  
lamellar bone

Stevens et al: Core Pathology, 3rd Edition.  
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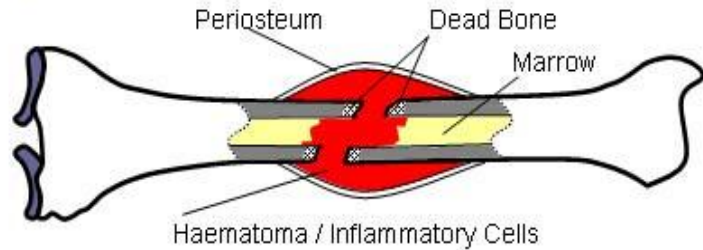


[www.bonefixator.com](http://www.bonefixator.com)

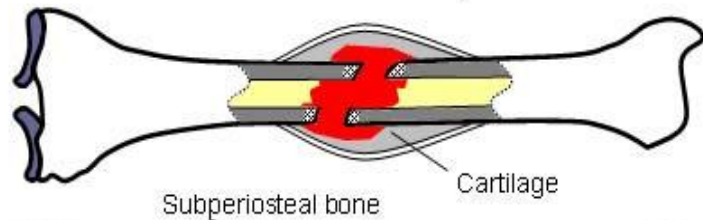
Stage 1 : Impact



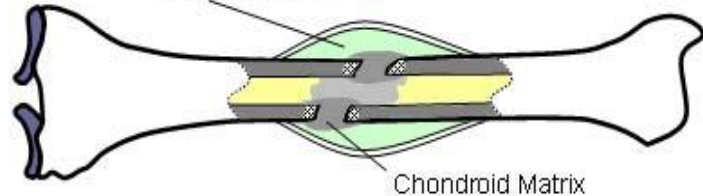
Stage 2 : Induction



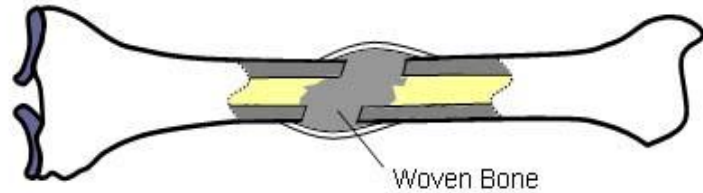
Stage 3 : Inflammation



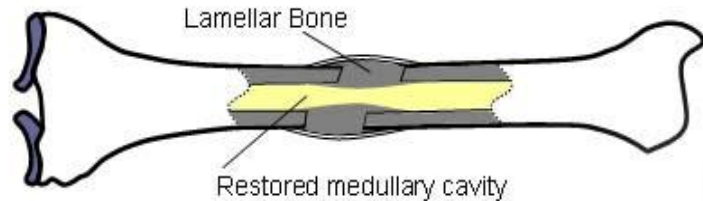
Stage 4 : Soft Callus



Stage 5 : Ossification



Stage 6 : Remodelling



# Healing of fractures

- Factors disrupting healing process:
  - Displaced and comminuted fractures
  - Infection
  - Vascular insufficiency
  - Inadequate minerals and vitamins
  - Inadequate immobilization

# *Problems*

- **Delayed union:** A fracture that takes longer to heal than expected is a delayed union.
- **Nonunion:** A fracture that fails to heal in a reasonable amount of time is called a nonunion (pseudarthrosis) “means false joint (looks like joint)”
- **Malunion:** A fracture that does not heal in a normal alignment is called a malunion



- Radiologist can tell if a patient had a fracture even after years
- If the fracture is in the joint: Arthritis, joint won't heal 100%, cartilage hurt



# *Problems*

## Compartment syndrome:

- Severe swelling after a fracture can put so much pressure on the blood vessels that not enough blood can get to the muscles around the fracture. The decreased blood supply can cause the muscles around the fracture to die, which can lead to long-term disability. Compartment syndrome usually occurs only after a severe injury.

### Compartment Syndrome symptoms :

sever swelling - inflammation - hematoma - edematous (edema) - secondary vascular insufficiency in focal or local area - pressure on the surrounding muscle – ischemia

Compartment Syndrome is treated with (surgical operation)

# *Problems*

- **Neurovascular injury**
- **Infection:** Open fractures can become infected
- **Post-traumatic arthritis:** Fractures that extend into the joints (intra-articular fractures) or fractures that cause the bones to meet at an abnormal angle in the joint can cause premature arthritis of a joint.

# *Problems*

- **Growth abnormalities:** A fracture in the open physis, or growth plate, in a child, can cause many problems. Two of these problems are premature partial or complete closure of the physis. This means that one side of a bone or the whole bone stops growing before it naturally would.

Growth abnormalities > after healing: the infected bone will look shorter than the other bones