

MUSCULOSKELETAL BLOCK

Pathology

Fracture and bone healing

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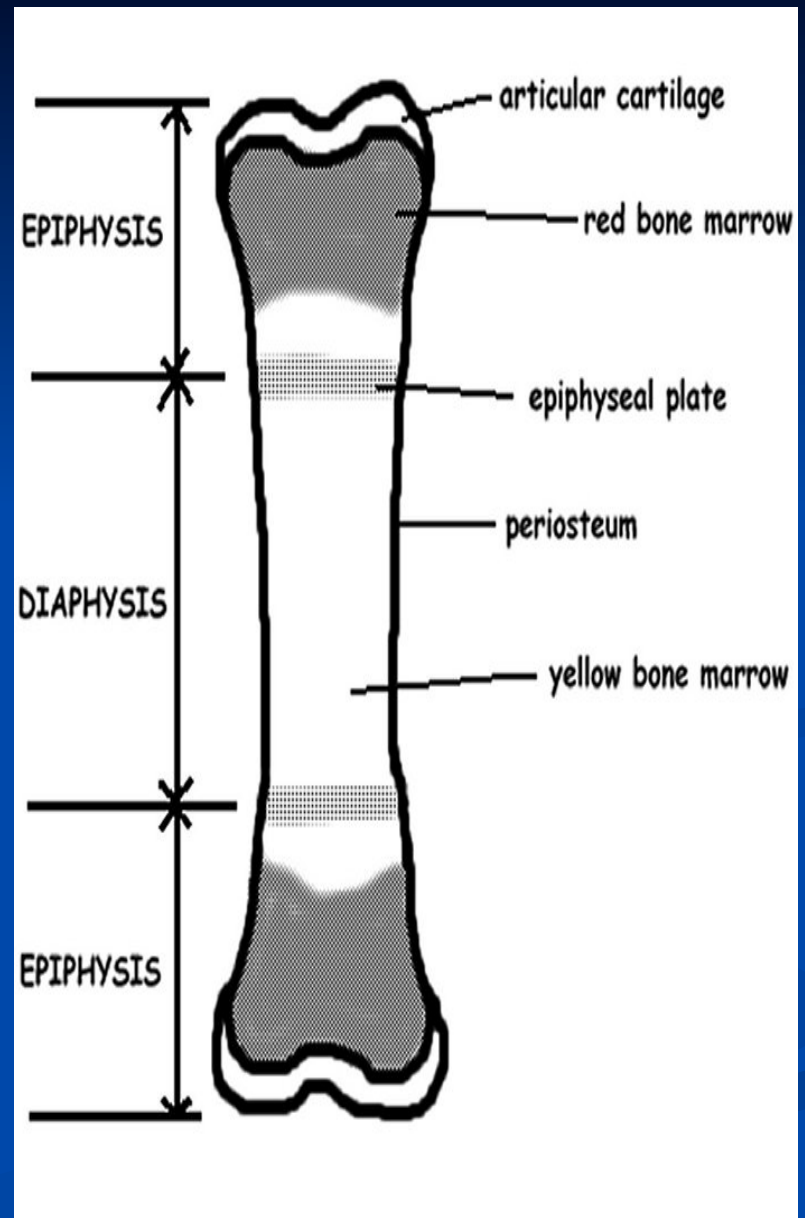
Healing of bone fractures

- Objectives of this lecture:
 - 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:

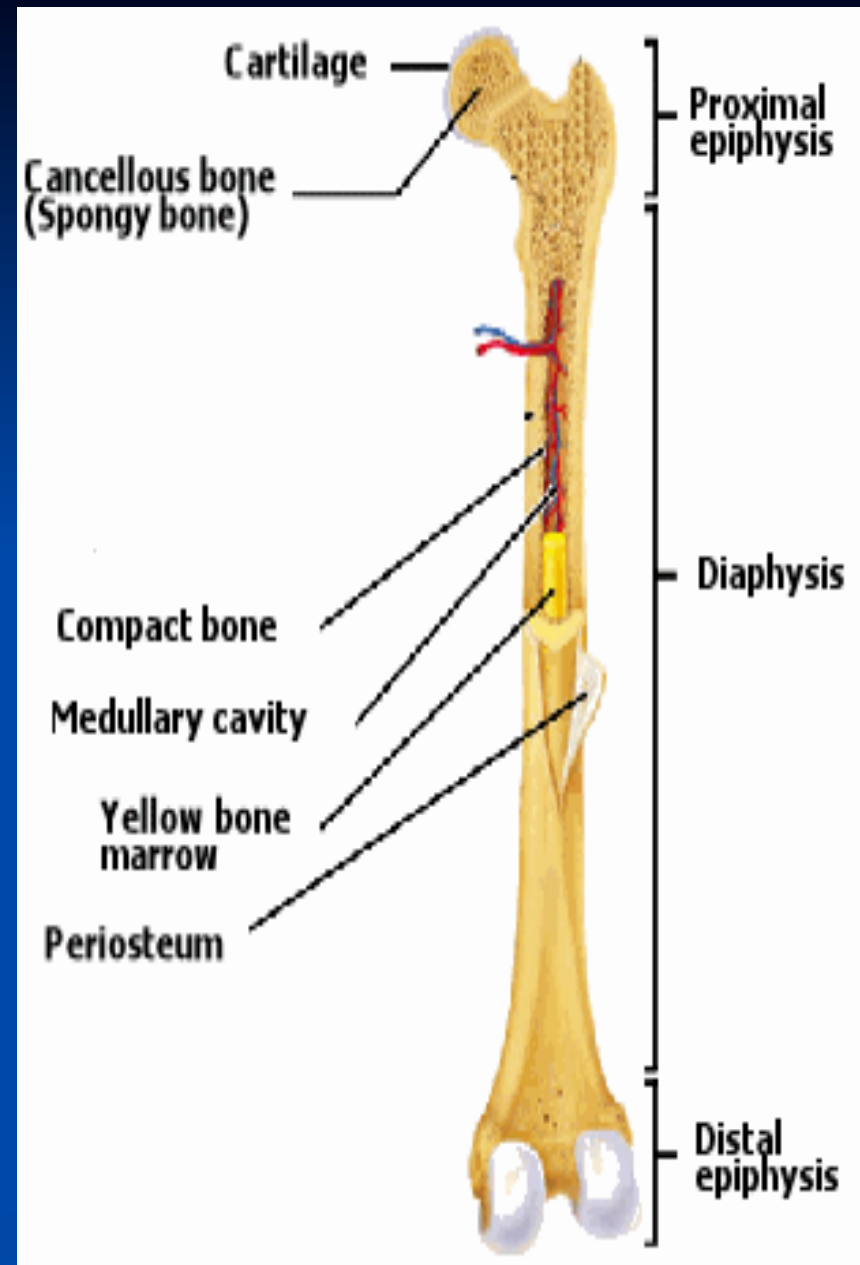
- epiphysis (ends of bone, partially covered by articular cartilage)
- physis (growth plate)
- metaphysis (junction of diaphysis and epiphysis)
- diaphysis (shaft)



Normal anatomy

■ Cross section:

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



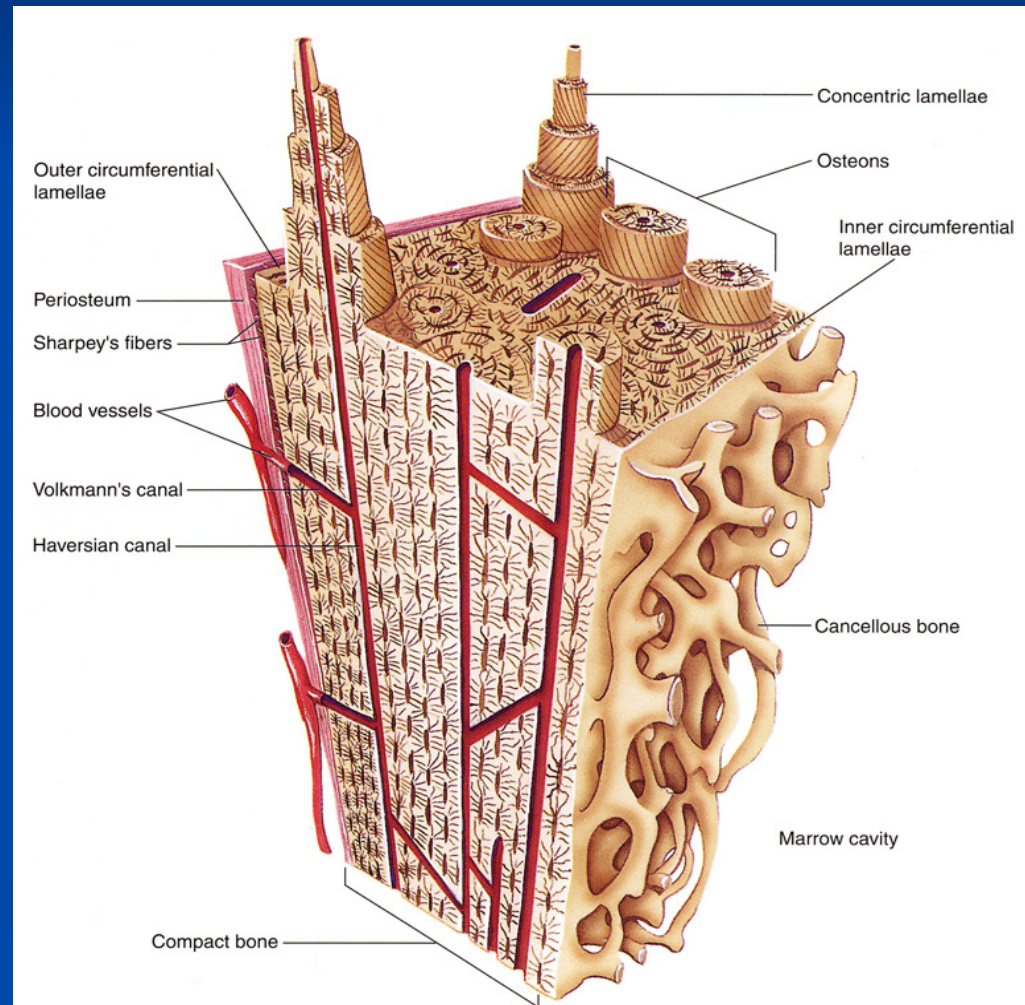


Normal histology

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

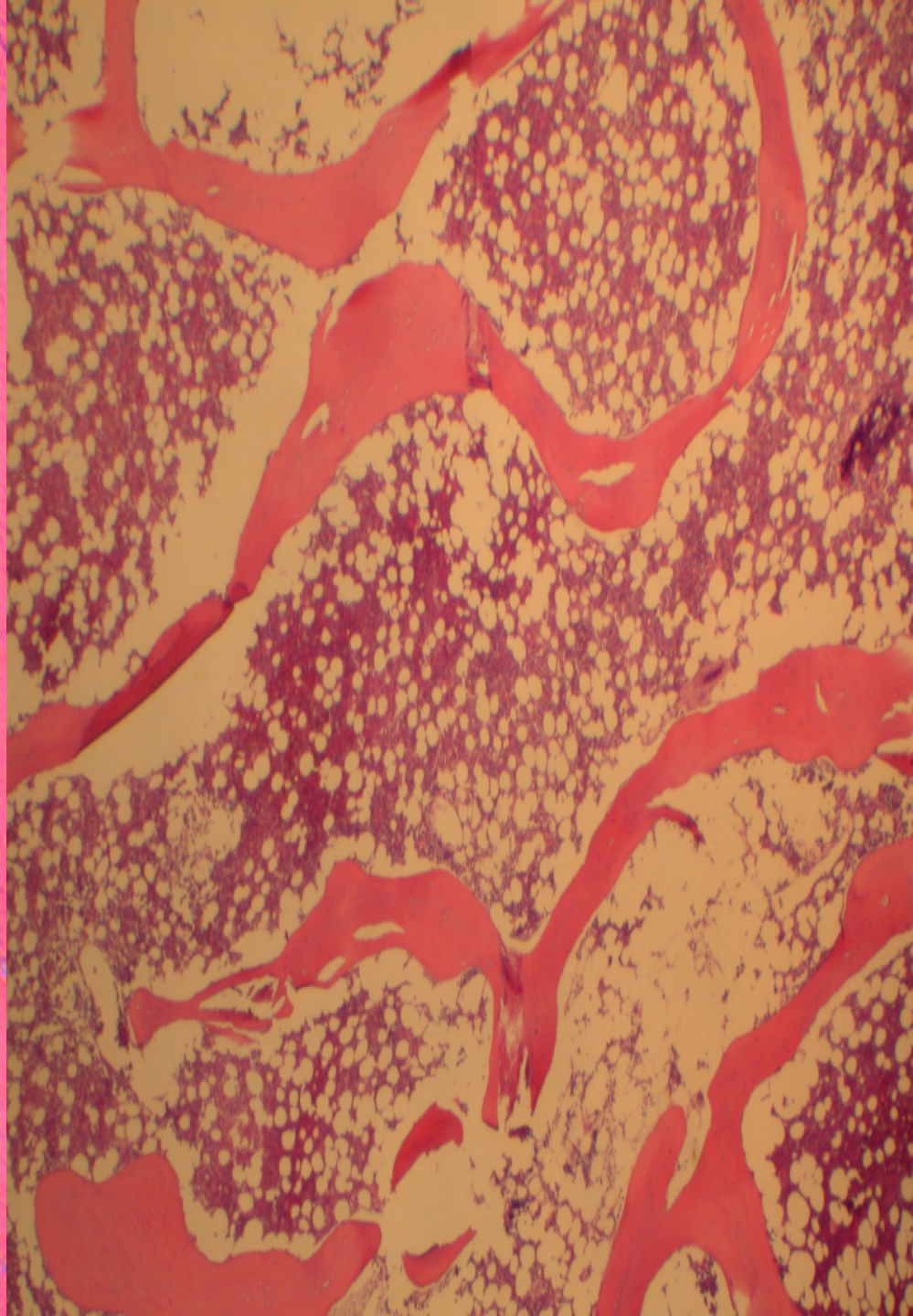
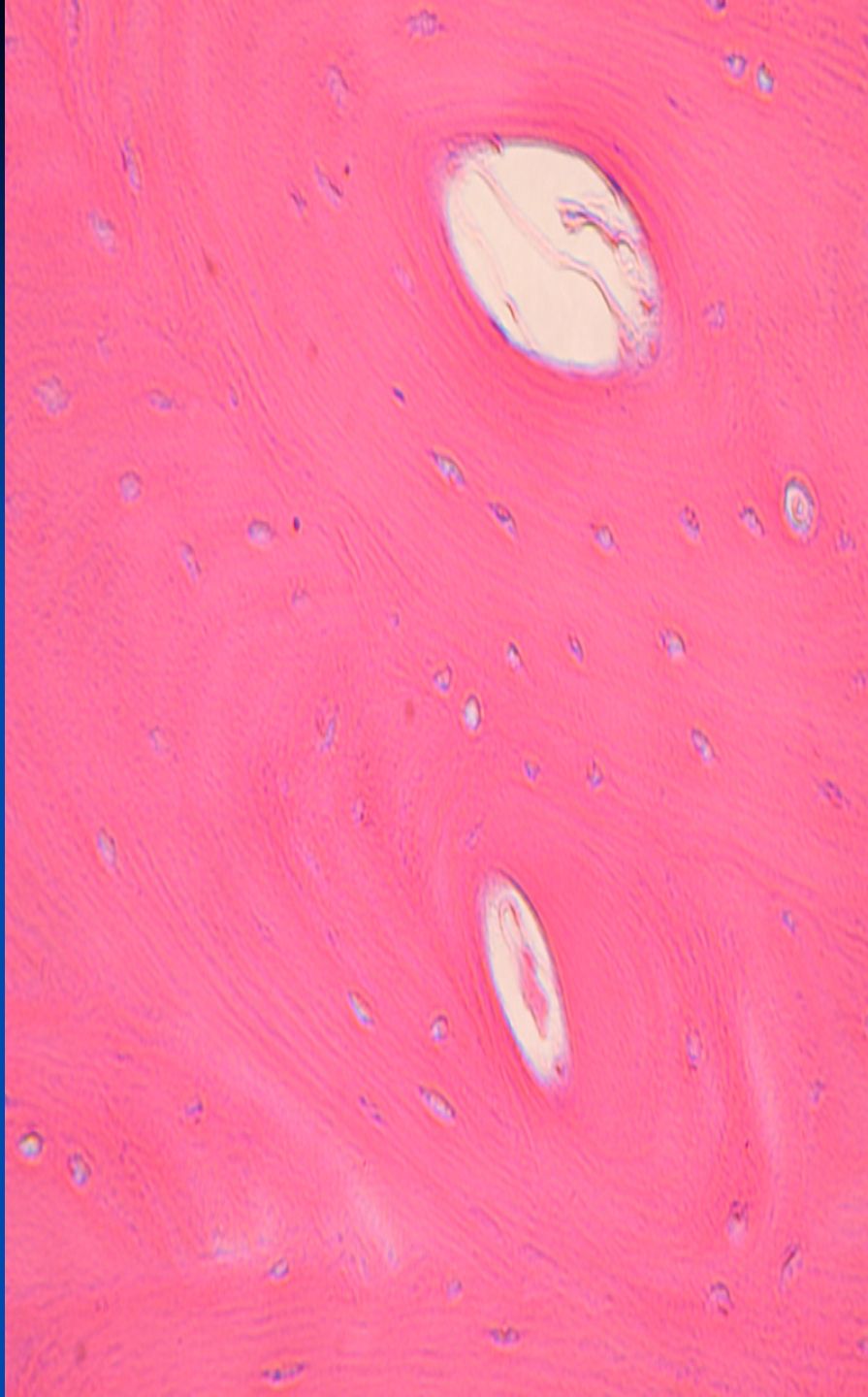
■ Lamellar bone:

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



- Bone is composed of specialized collagen (osteoid), which is mineralized by the deposition of hydroxyapatite
- Bone is composed of a collagen-containing extracellular matrix (osteoid) synthesized by osteoblasts, which is mineralized by calcium-containing salts

- There are two main patterns of bone deposition.
- In normal lamellar bone the osteoid collagen is deposited in a mechanically strong, parallel stratified pattern.
- In woven bone, the osteoblasts deposit osteoid collagen in a haphazard pattern. With its random arrangement of osteoid collagen fibers, this woven pattern is far less efficient and much weaker than lamellar bone with a greater tendency to fracture under stress.



Bone Cells

- **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.

- **osteoid** is the unmineralized, organic portion of the bone matrix that forms prior to the maturation of bone tissue. Osteoblasts begin the process of forming bone tissue by secreting the **osteoid** as several specific proteins.
- Bone resorption:

Bone resorption is **resorption** of **bone** tissue, that is, the process by which osteoclasts break down the tissue in **bones**

Fracture:-

Break in the continuity of bone



Fig. 1 Complete fracture



Fig. 2 Incomplete fracture

A fracture is defined as breakage in a
bone

The fracture can be



Complete

or



Incomplete

Defintions.

- Closed fracture (simple).
- Open fracture (compound).
- Complicated fracture.

Types of Fractures

Simple



Compound



Greenstick



Comminuted



Defintions

■ Closed Fracture (simple):-

Does **NOT**
communicate with
external environment

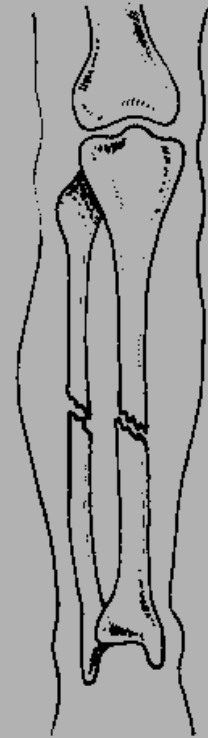


Fig 3. closed fracture
tibia

Defintions.

■ Open Fracture (**compound**):-

Communicate with
external environment

Infection !!



COMPOUND #
Fracture extend to
the skin

Fig. 4 Open fracture tibia

Defintions

■ Complicated Fracture:-

Associated with damage to nerves, vessels or internal organs

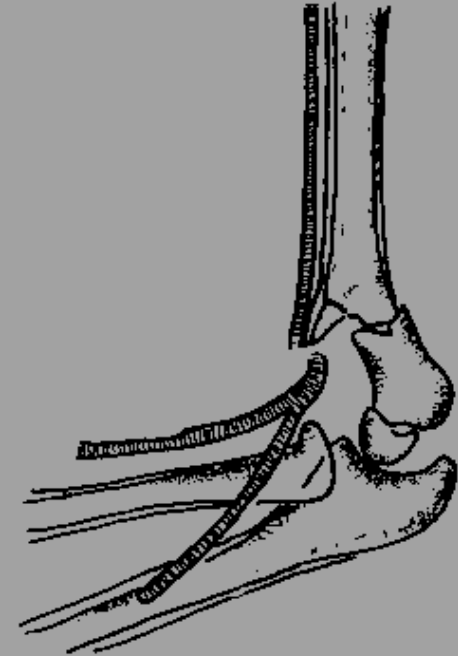
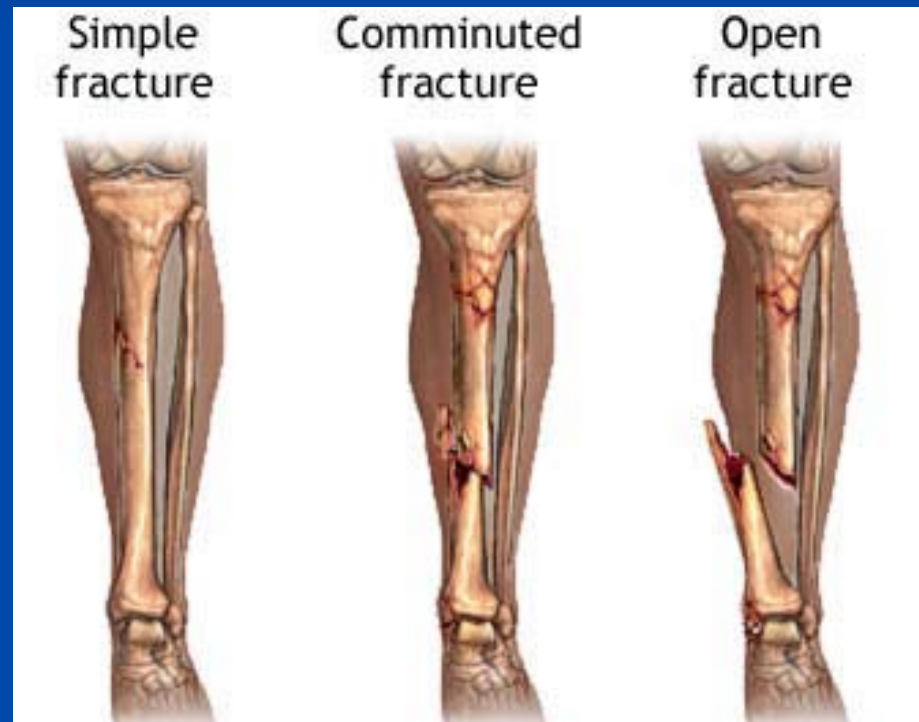


Fig. 5 A supracondylar fracture of the humerus with damage to the brachial artery

Classification of fractures

- Complete or incomplete
- Closed or compound
- Comminuted
- Displaced



Greenstick Fracture



Causes of fractures

- Traumatic fracture: Sever trauma
- Pathological fracture
- Stress fracture

Causes of fractures

- Traumatic fracture: Severe trauma e.g. MVA
- Trauma due to motor vehicle accidents is of major cause of bone fracture

Causes of fractures

- Pathological fracture:
 - Fracture occur with **minimal trauma**
 - the underlying bone is abnormal e.g.
 - Osteoporosis
 - Osteomalacia
 - Paget's disease of bone
 - Primary or metastatic tumor.
 - Congenital bone disorders
e.g. osteogenesis imperfecta



Stress fracture

A *stress fracture* is a slowly developing fracture that follows a period of increased physical activity in which the bone is subjected to new repetitive loads.

Stress fractures are most common in the weight-bearing bones of the lower leg and foot. Track and field athletes and military recruits who carry heavy packs over long distances are particularly susceptible



Healing of fractures

1. Reactive Phase

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

2. Reparative Phase

- iii. Callus formation
- iv. Lamellar bone deposition

3. Remodeling Phase

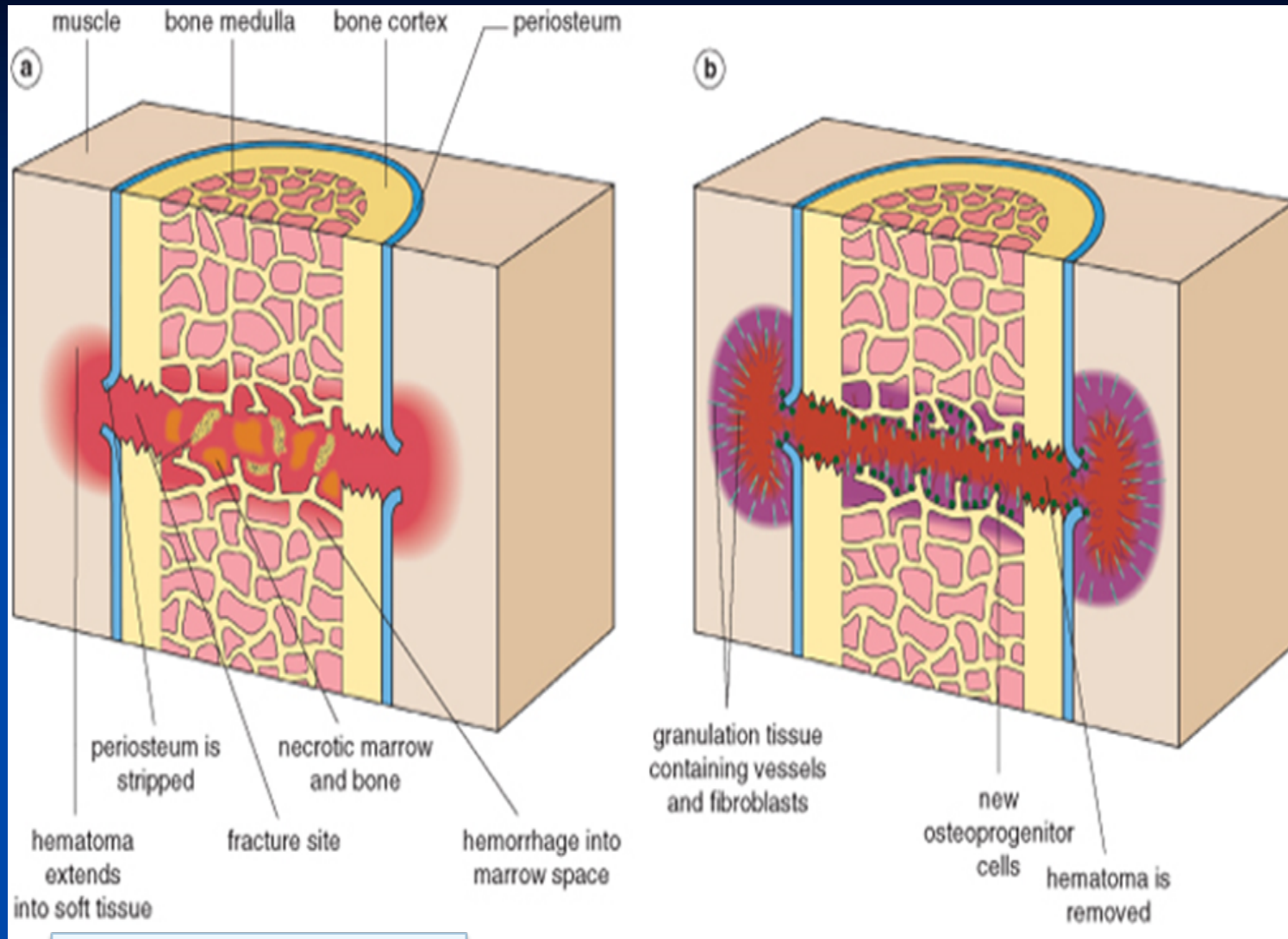
- v. Remodeling to original bone contour

How does a fracture heal?

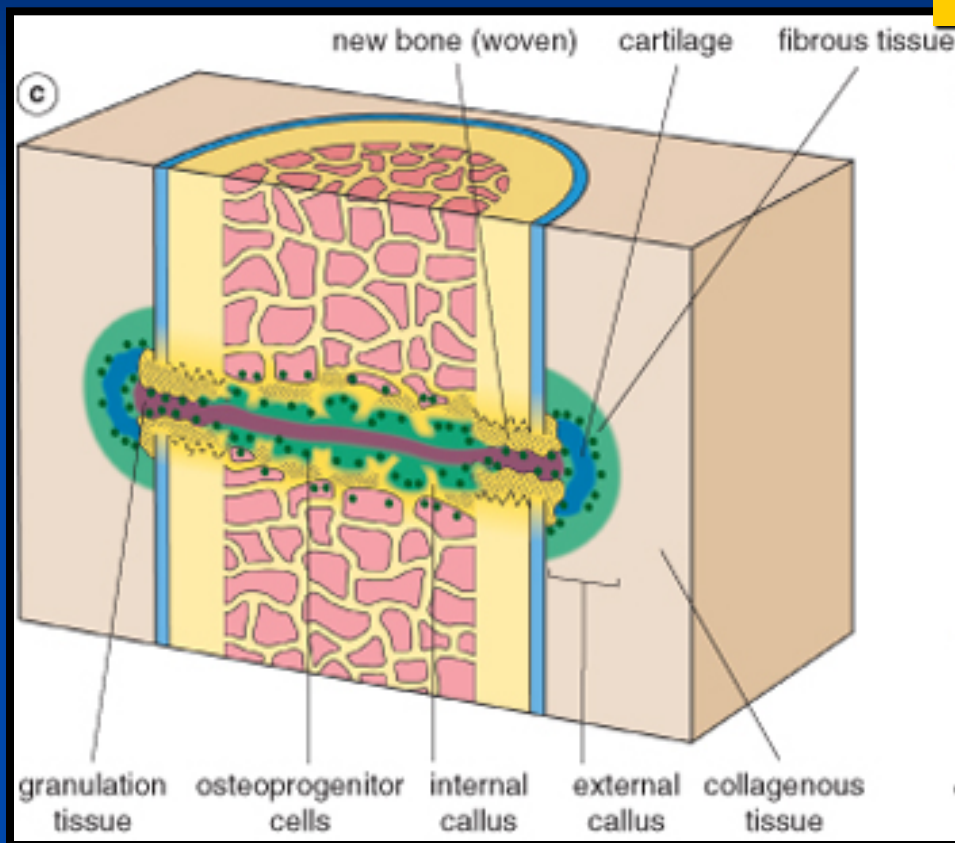
Reactive Phase

Stage 1: Inflammation

- Bleeding from the fractured bone and surrounding tissue causes the fractured area to swell due to inflammation induced by chemical mediator produced from macrophages and other inflammatory cells with granulation tissue formation.



This stage begins day one of bone fracture and lasts about 2 to 3 weeks.



degranulated platelets and migrating inflammatory cells release PDGF, TGF- β , FGF, and other factors, activate osteoprogenitor cells in the periosteum, medullary cavity, and surrounding soft tissues and stimulate osteoclastic and osteoblastic activity.

Reparative Phase

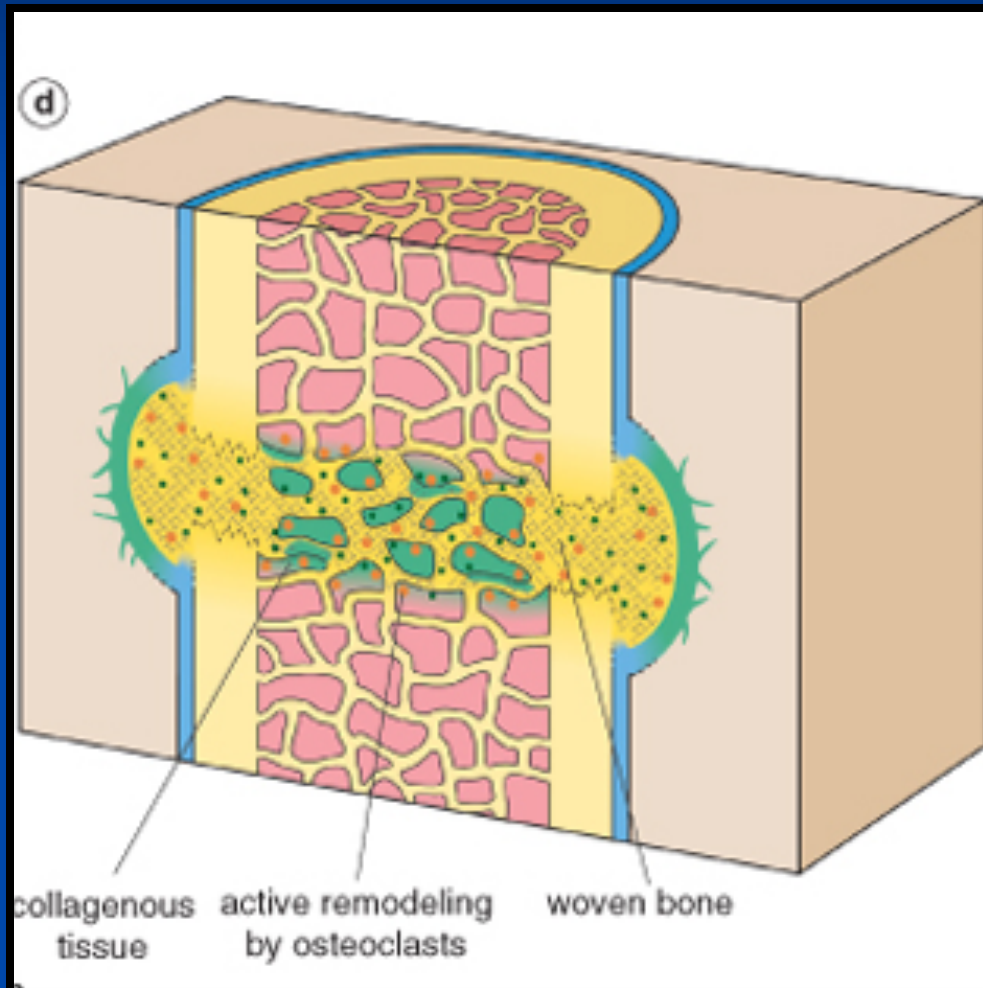
■ Soft callus

by the end of the first week the hematoma is organizing, the adjacent tissue is being modulated for future matrix production, and the fractured ends of the bones are being remodeled. This fusiform and predominantly uncalcified tissue—called soft-tissue callus or procallus

■ Hard callus

- Osteoblasts produce woven bone, resulting in a bony callus that stabilizes the fracture site.

Hard callus



Immobilization promotes bone fracture healing

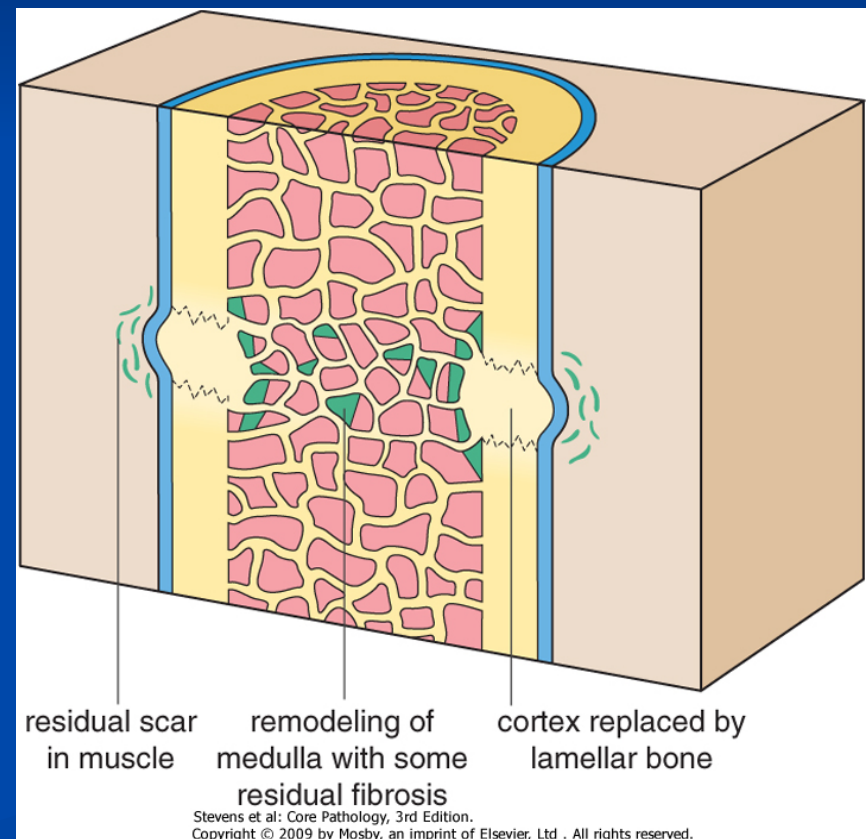


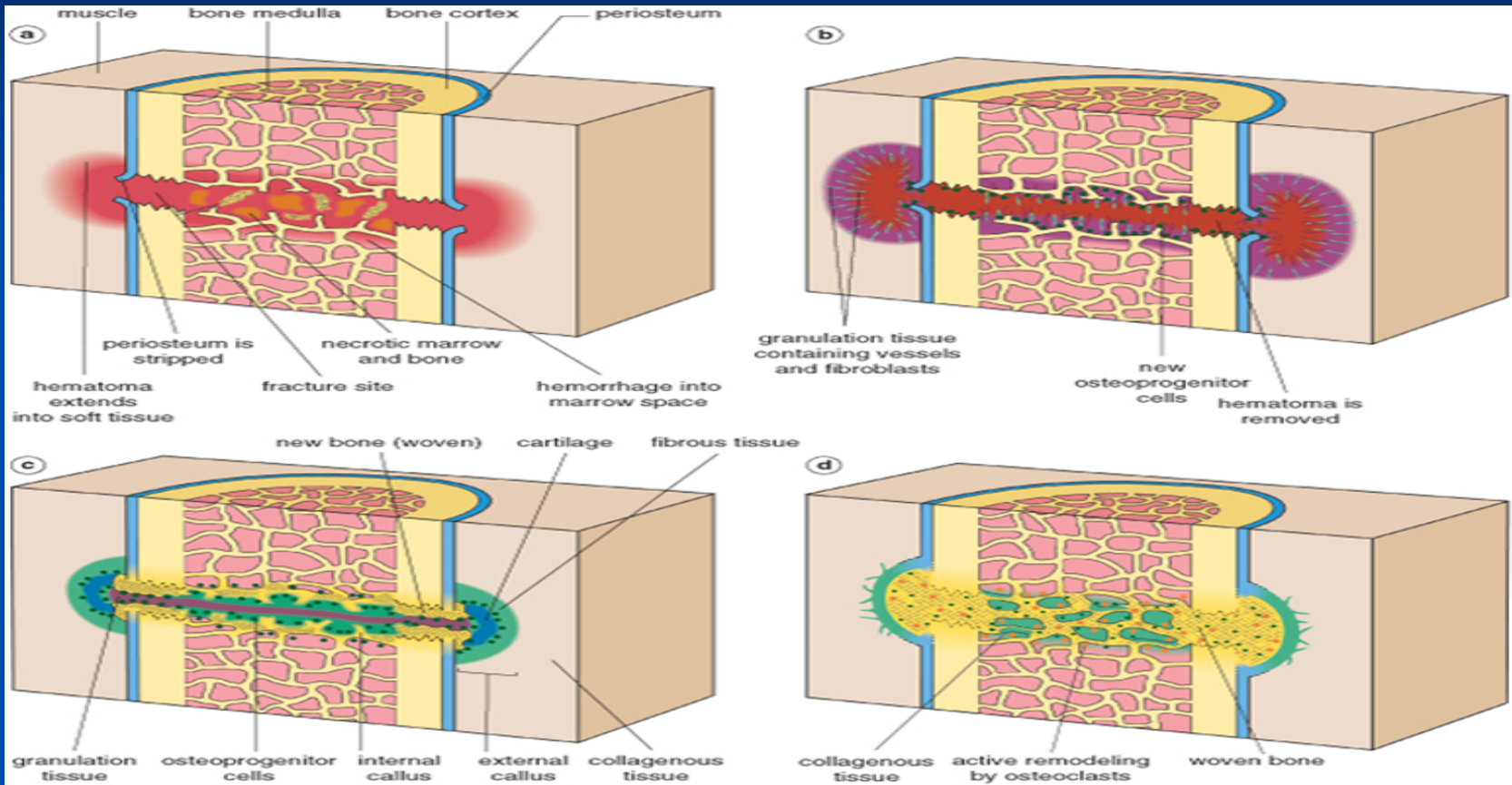


Bone remodeling

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
 - age
 - health
 - the kind of fracture
 - the bone involved.





Stevens et al: Core Pathology, 3rd Edition.
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Healing of fractures

- Factors disrupting healing process:
 - Displaced and comminuted fractures
 - Infection
 - Vascular insufficiency

This is particularly important in certain areas such as the scaphoid bone in the wrist and the neck of the femur, both of which can be associated with **avascular necrosis** of fracture fragments.

- Inadequate minerals and vitamins
- Inadequate immobilization

COMPLICATIONS

- **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)



COMPLICATIONS

- **Malunion:-**

- **Malunion:** A fracture that does not heal in a normal alignment is called a malunion



COMPLICATIONS

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.

COMPLICATIONS

- **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.

COMPLICATIONS

- **Growth abnormalities:** A fracture in the open physis, or growth plate, in a child, can cause many problems.