General outline of fractures and fracture healing

Learning objectives

- Anatomy
- Types of fractures
- Mechanism of injury
- Morphology of various fracture types
- General healing principles
- Types of healing

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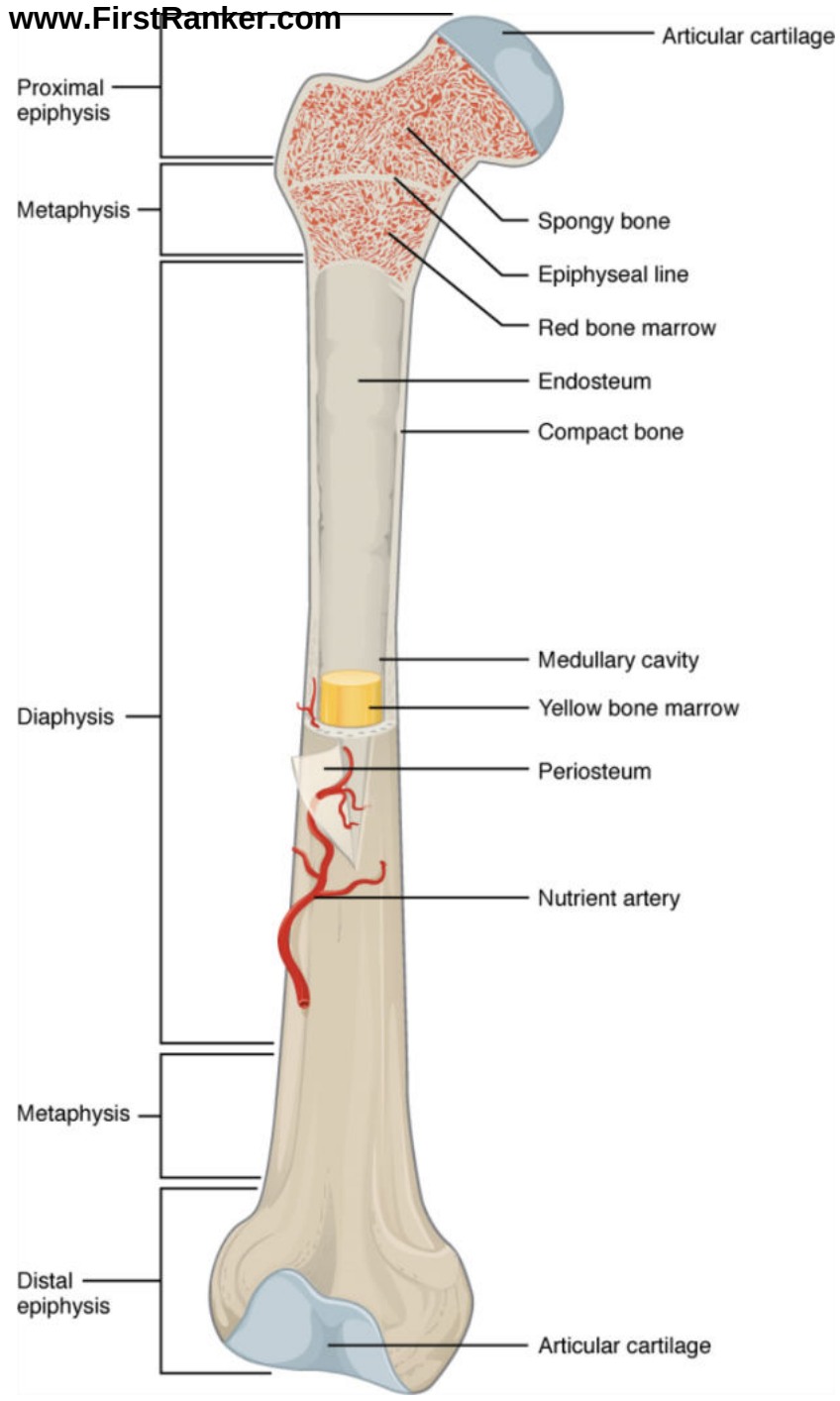
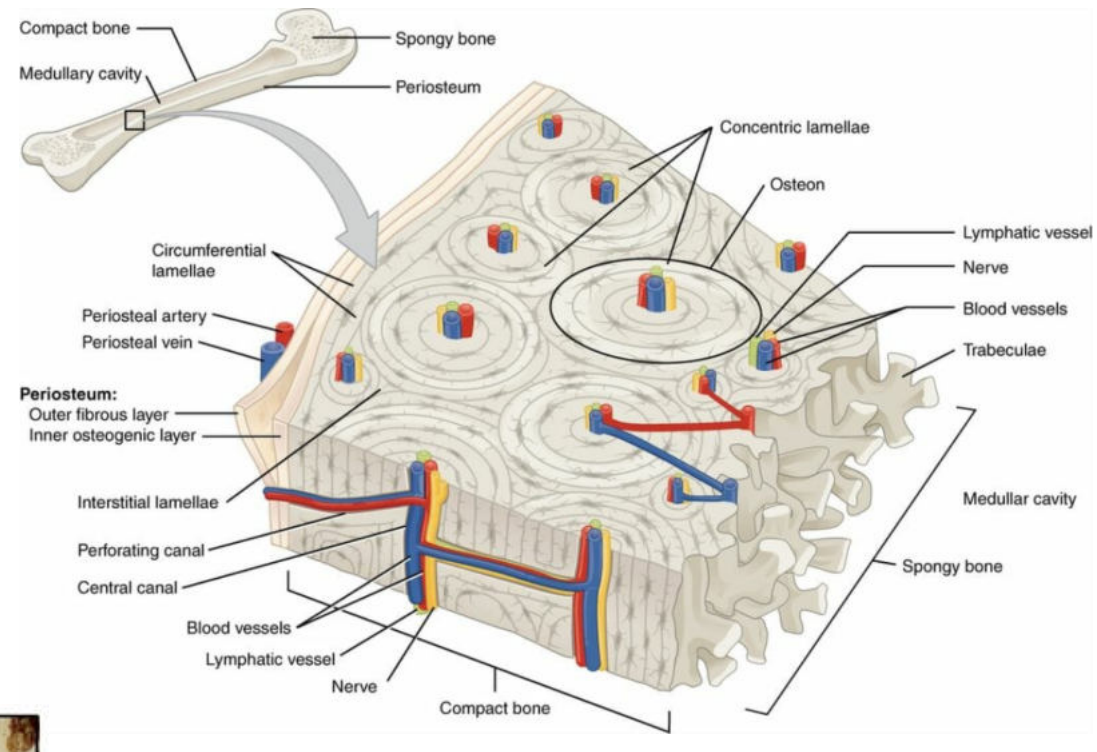
Anatomy

- Bone has been divided into-
  - a. Epiphysis
  - b. Metaphysis
  - c. Diaphysis

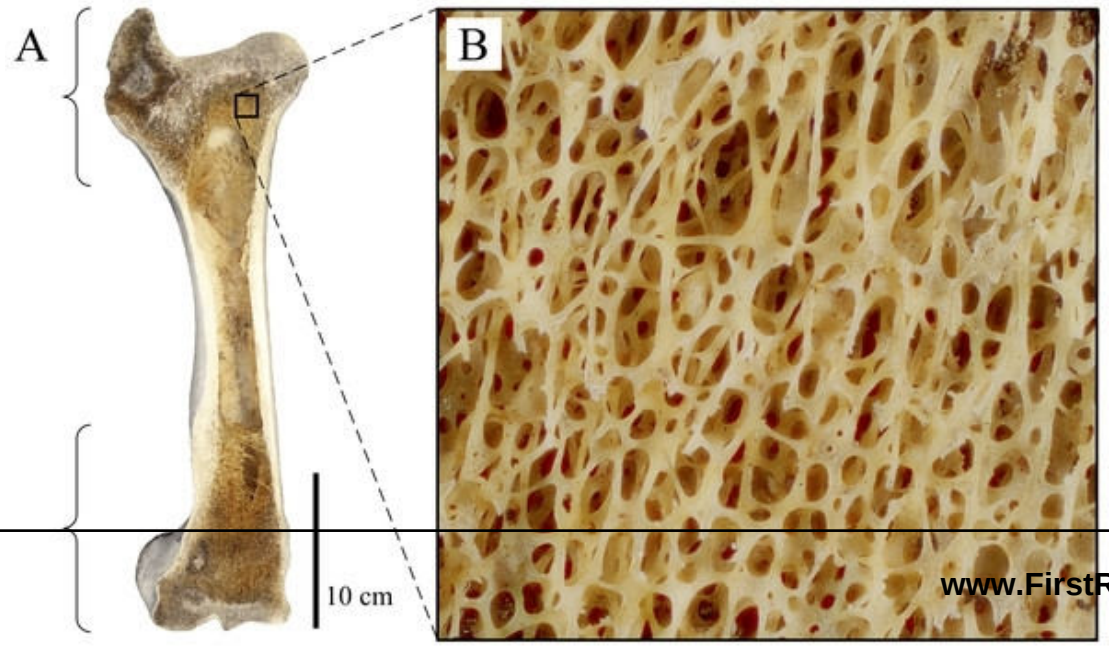


Types of bone

- Cancellous/Spongy



- Cortical/Compact



Fractures

- Break in the structural continuity of bone

Types of Fracture

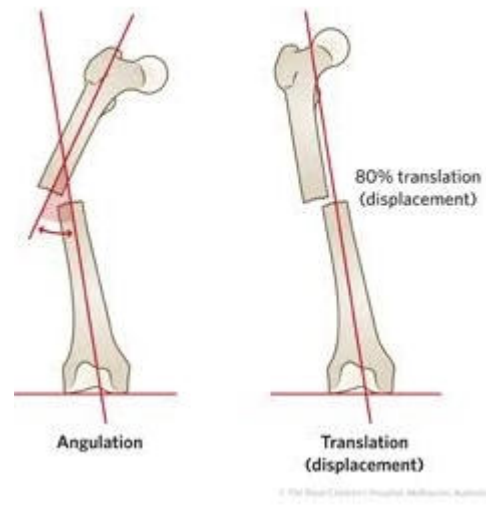
- Divided into
  - Complete
  - Incomplete

Types of Fractures

- Based on aetiology-
  - A. Traumatic
  - B. Pathological
  - C. Stress

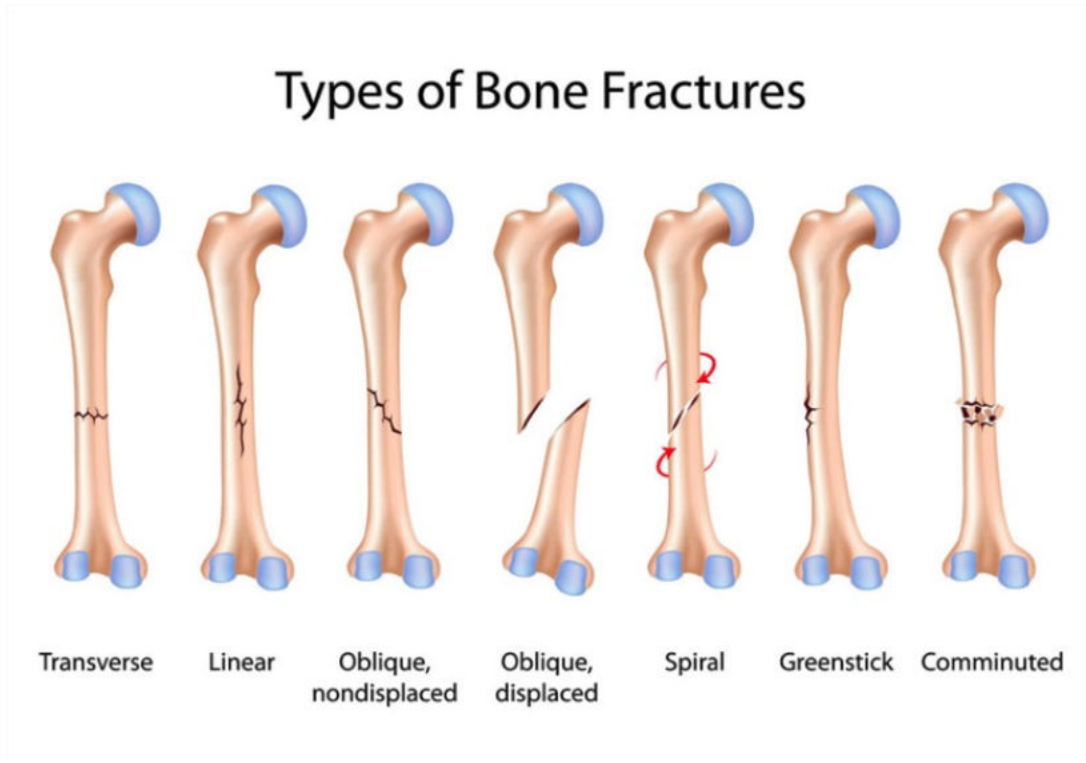
Types of fractures

- Based on Displacement-
  - A. Undisplaced
  - B. Displaced- Translation, angulation, twisting



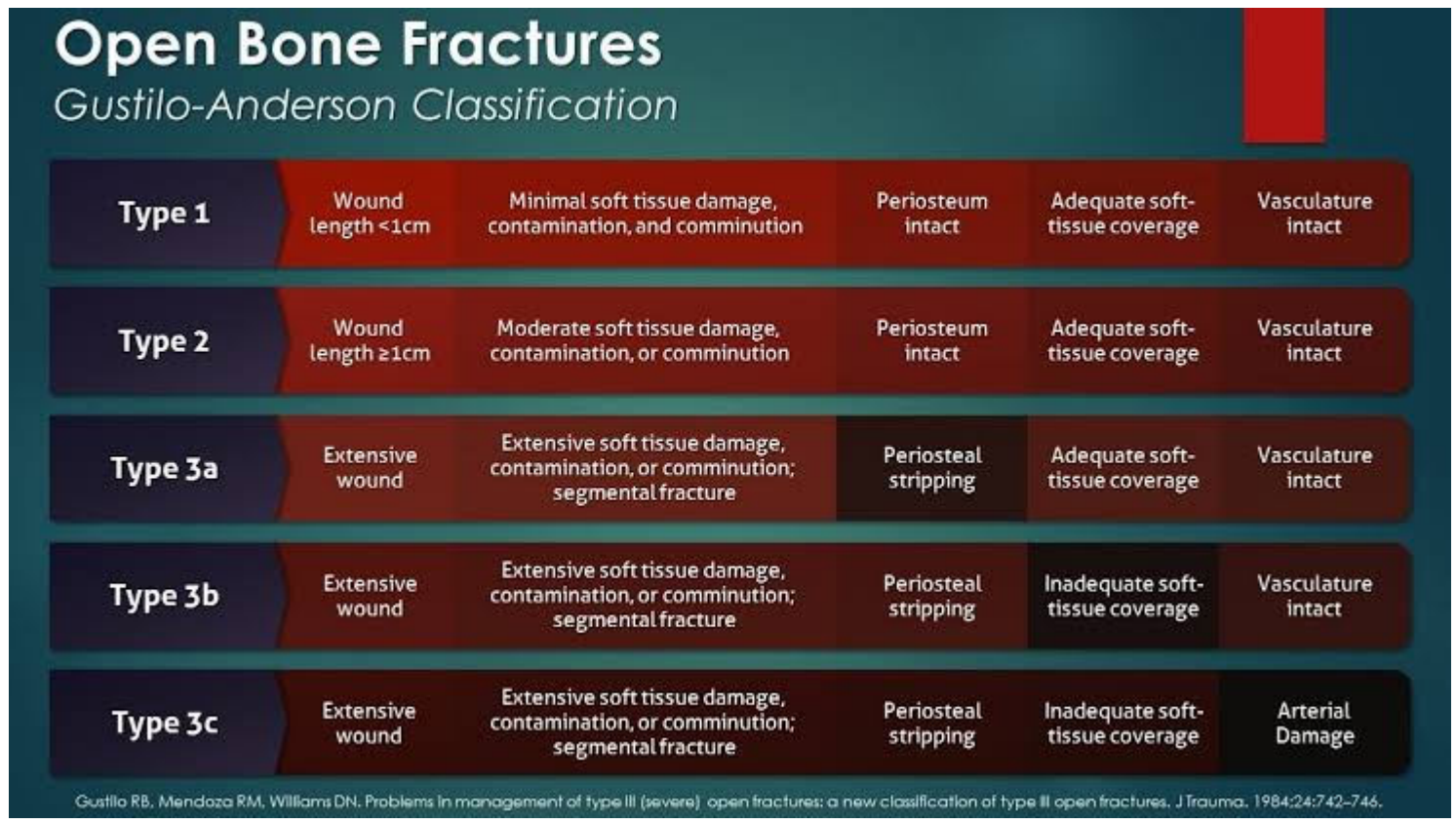
Types of Fractures

- Based on relationship to external environment
  - A. Closed
  - B. Open
- Based on Pattern
  - A. Spiral
  - B. Oblique
  - C. Transverse
  - D. Communited
  - E. Segmental



Open fracture

Open fracture



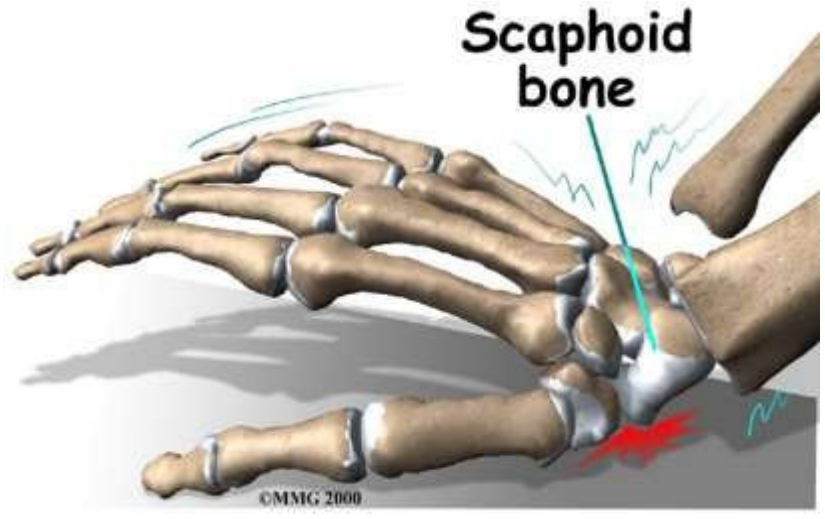
Mechanism

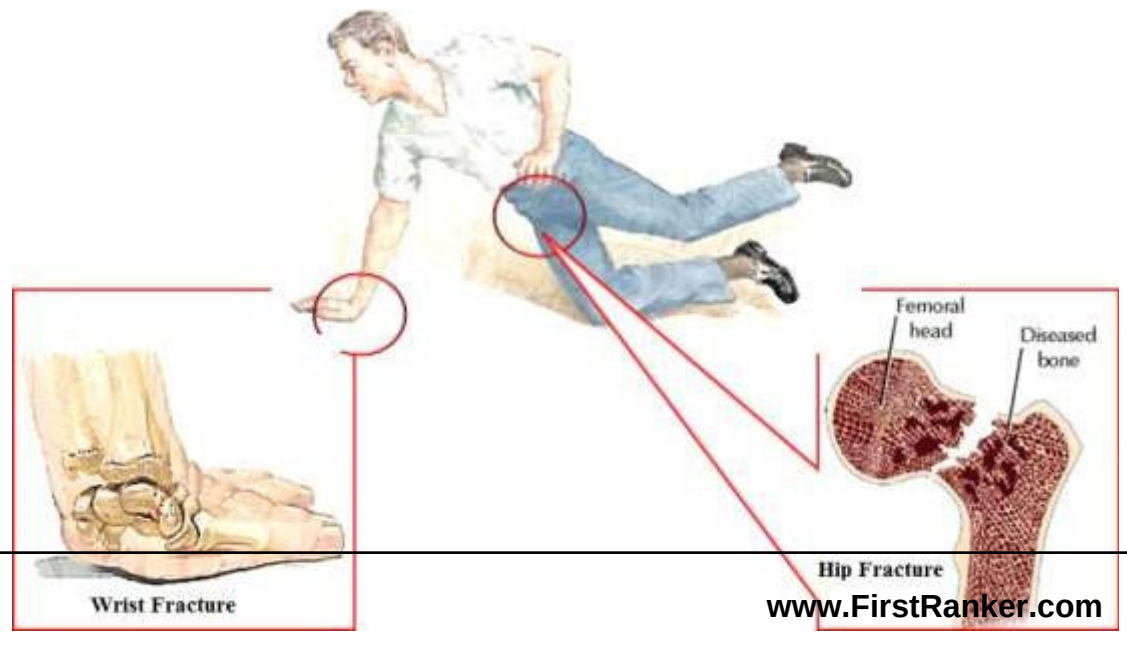
- Injury
- Repeated Trauma
- Pathological Fracture

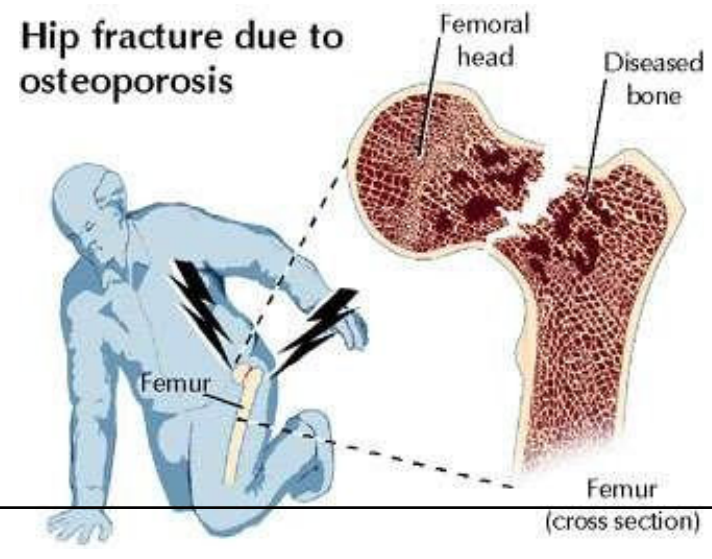
Injury

- Low velocity
- High velocity

Colles fracture



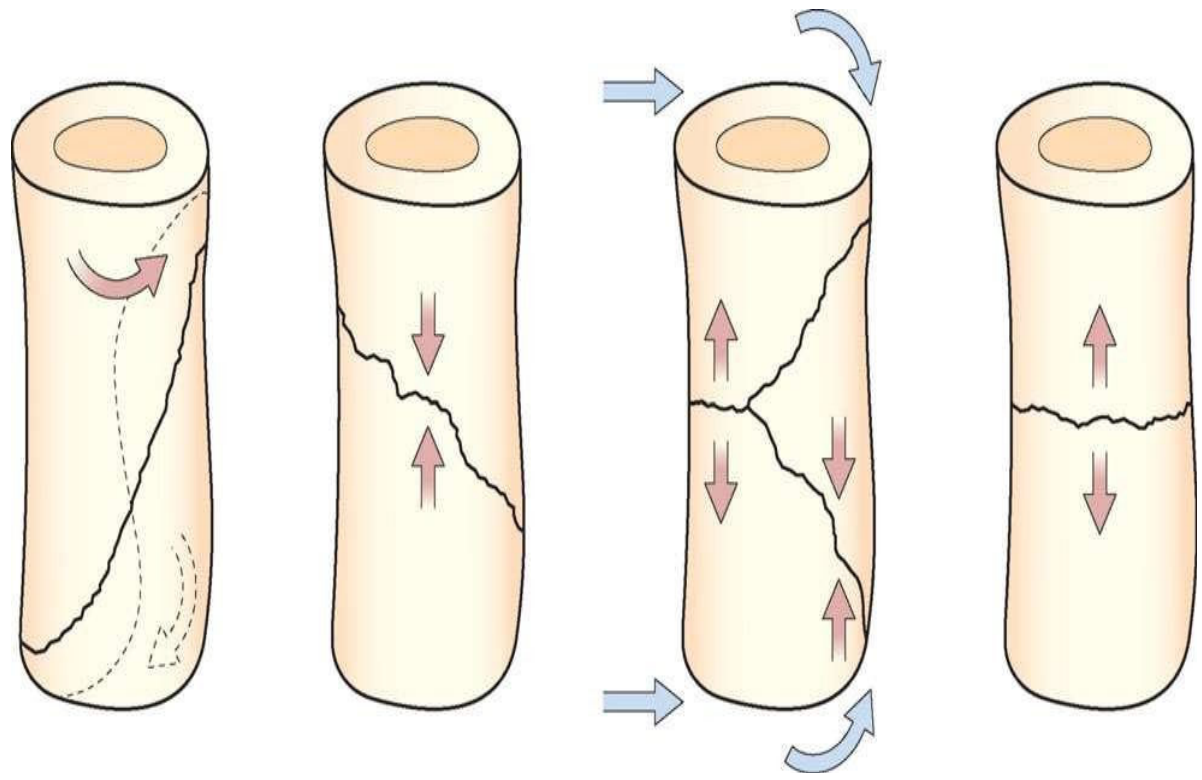




Mechanism

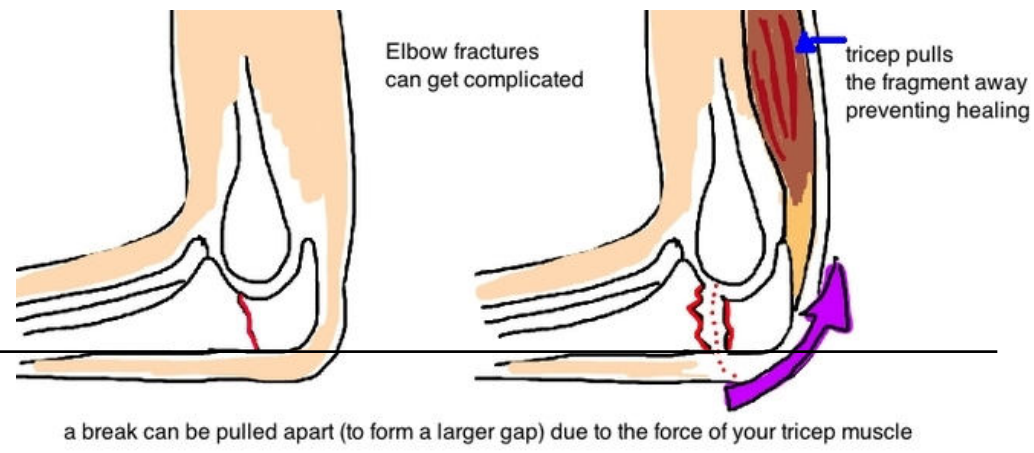
Some fracture patterns reveals the dominant mechanism:

- Spiral pattern- twisting
- Oblique- compression
- Triangular- bending
- Transverse- tension



Extent of displacement

- Force of injury
- Effects of gravity
- Pull of muscles attached to site



a break can be pulled apart (to form a larger gap) due to the force of your tricep muscle

Repeated trauma

- Occur in normal bone, subject to repeated heavy loading, typically in athletes, dancers or military personnel.

- Drugs like steroids and methotrexate

Stress fracture

PATHOLOGICAL FRACTURES

- Occurs in a bone that is made weak by some disease.

- Causes-

  Inflammatory- Osteomyelitis

  Neoplastic- giant cell tumor, Ewing's sarcoma, secondaries

Pathological fracture

- Miscellaneous bone conditions- simple bone cyst, anuerysmal bone cyst, metastasis

- Hereditary- Osteogenesis imperfecta, Osteopetrosis

- Other acquired generalised diseases- Osteoporosis, osteomalacia, rickets

Pathological fracture

Fracture healing

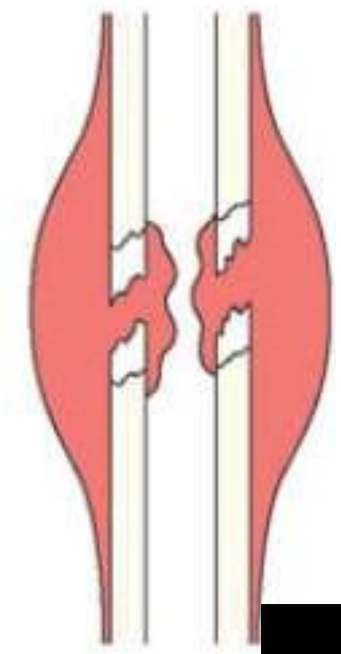
- Process of **proliferative physiological process** in which body facilitates healing with various cells and growth factors
- Cells- Osteoblast, Osteoclast main cells
- Various growth factors

HISTORY

- In 1975, **Cruess and Dumont** proposed that fracture healing may be considered to consist of three overlapping phases: *an inflammatory phase, a reparative phase, and a remodeling phase*
- In 1989, **FROST** proposed the stages of fracture healing

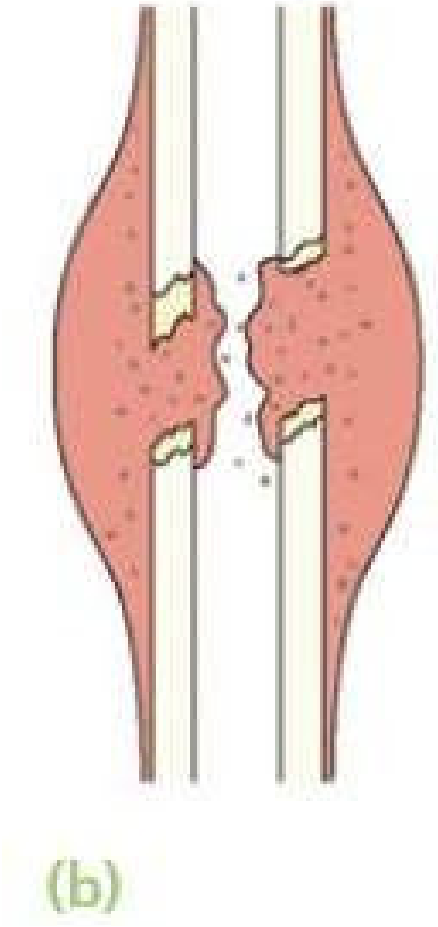
five stages.

stage of hematoma
stage of granulation tissue
stage of callus
stage of consolidation
stage of remodelling

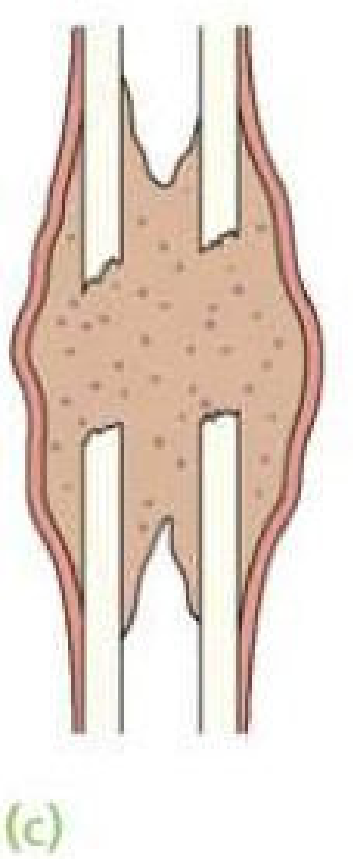


HEALING BY CALLUS

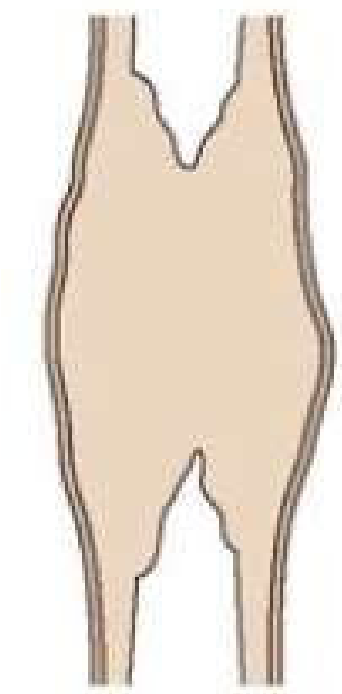
- STAGE 1: **TISSUE DESTRUCTION AND HEMATOMA FORMATION**
  - lasts for 7 days
  - blood leaks out of torn vessels and forms a hematoma between and around fracture
  - periosteum and local soft tissues are stripped off
  - ischaemic necrosis – death of some osteocytes with sensitization of the remaining precursor cells



- STAGE 2: **INFLAMMATION AND CELLULAR PROLIFERATION/GRANULATION TISSUE**
  - lasts for 2-3 weeks
  - precursor cells form cells that differentiate and organize to provide vessels, fibroblasts, osteoblasts etc
  - soft granulation tissue formed between fracture fragments, providing anchorage to fracture
  - hematoma is slowly absorbed and fine new capillaries grow into the area



- STAGE 3: **CALLUS FORMATION**
  - lasts for 4-12 weeks
  - granulation tissue differentiates and creates osteoblasts, laying down intercellular matrix impregnated with calcium salts
  - formation of callus/woven bone
  - provides good strength to the fracture, decreasing the movements at the fracture site and causes union in about 4 weeks



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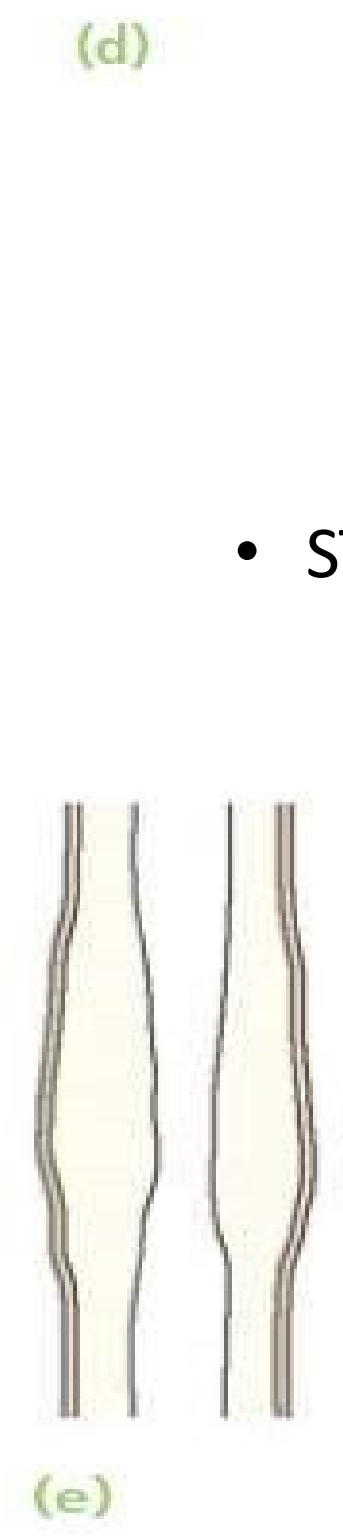

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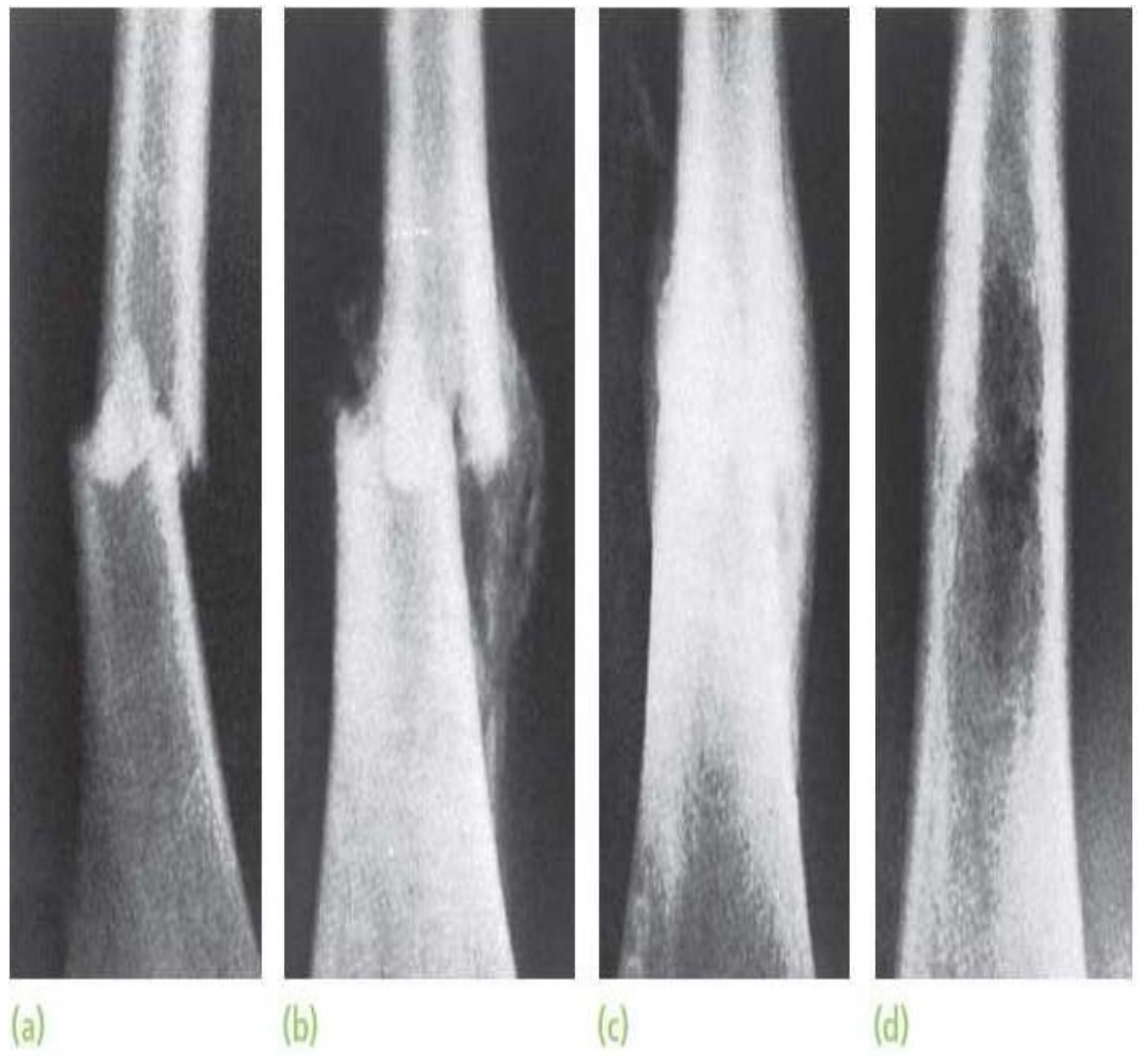
- STAGE 4: **CONSOLIDATION**
  - takes 1-4 years for the bone to become strong enough to carry weight
  - with continuing osteoclastic and osteoblastic activities, the woven bone gets transformed into lamellar bone
  - osteoblasts fill in the remaining gap between the new bone and the fragments to strengthen the bone

- STAGE 5: **REMODELLING**
  - stage where the bone is gradually strengthened
  - shapening of the cortices occurs at the endosteal and periosteal surfaces
  - all these occur when the person starts resuming his activities ie bearing weight and muscle forces
  - thicker lamellae are laid down where high stresses are present, unwanted buttresses are carved away and medullary cavity is reformed



23.7 Fracture repair (a) Fracture; (b) union; (c) consolidation; (d) bone remodelling. The fracture must be protected until consolidated.

Types for Bone Healing

- Direct (primary) bone healing
- Indirect (secondary) bone healing

Direct Bone Healing

- Mechanism of bone healing seen when there is no motion at the fracture site (i.e. absolute stability)

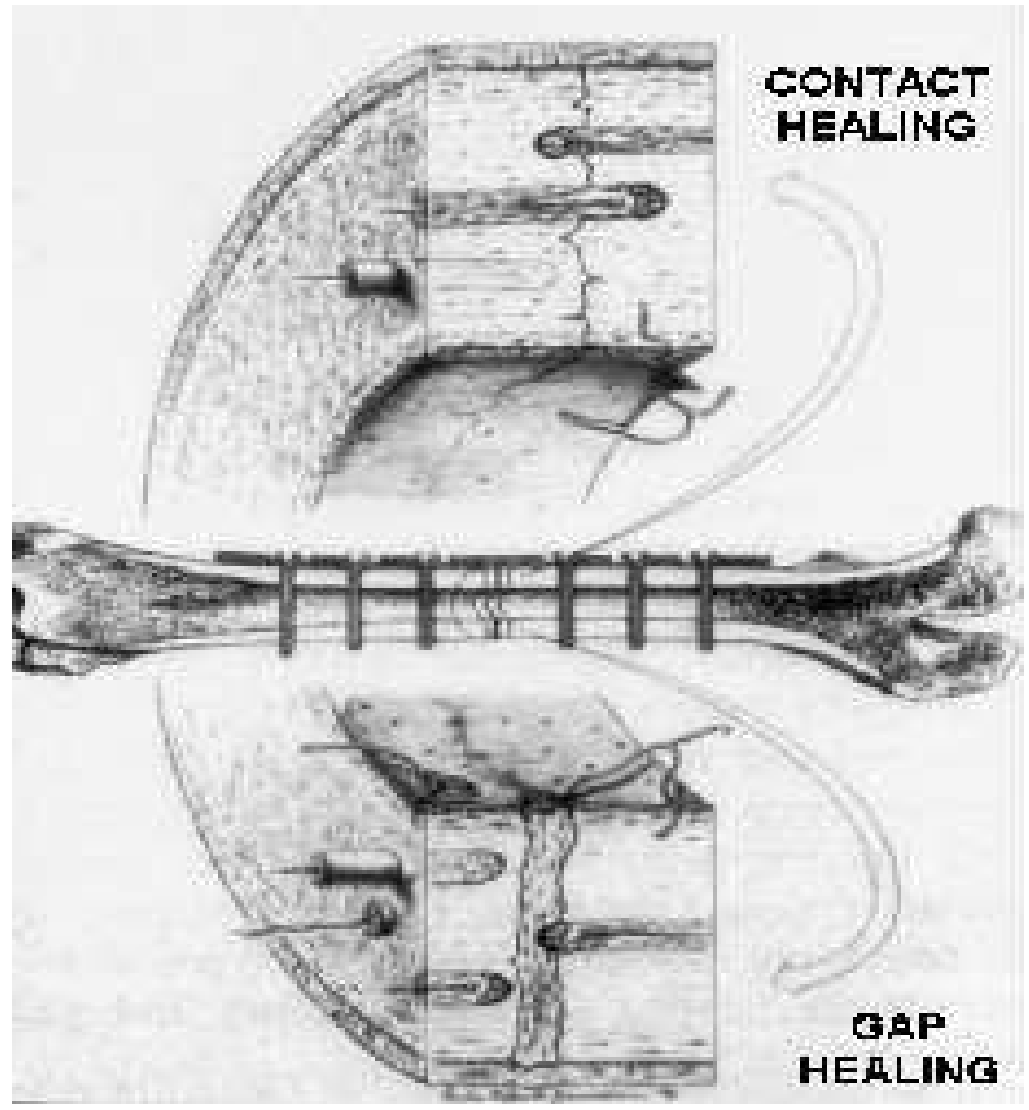
- Does not involve formation of fracture callus

- Osteoblasts originate from endothelial and perivascular cells

Components of Direct Bone Healing

- Contact Healing
  - Direct contact between the fracture ends allows healing to be with lamellar bone immediately
- Gap Healing
  - Gaps less than 200-500 microns are primarily filled with woven bone that is subsequently remodeled into lamellar bone
  - Larger gaps are healed by indirect bone healing (partially filled with fibrous tissue that undergoes secondary ossification)

Direct Bone Healing



Indirect Bone Healing

- Mechanism for healing in fractures that have some motion, but not enough to disrupt the healing process.
- Bridging periosteal (soft) callus and medullary (hard) callus re-establish structural continuity
- Callus subsequently undergoes endochondral ossification
- Process fairly rapid - weeks

Q1

- A patient has come to our emergency with fracture tibia of right side with wound on anteriomedial aspect of shin of tibia of 3 cm. the wound can be closed by primary suturing as appear on secondary examination. Patient had an rta 2 hours back. Please classify the fracture according to gustilo Anderson classification?

a. Grade I
b. Grade II
c. Grade IIIa
d. Grade IIIb

Q2

- How is direct fracture healing differ from indirect fracture healing?

a. Stage of hematoma
b. Stage of callus formation
c. Stage of remodeling
d. Stage of consolidation

Q3

A 70 year old male patient developed pain in his left shoulder while turning in bed. He is a known case of pulmonary malignancy and is on chemotherapy for the same. Xray shows a lytic lesion in the proximal humerus with a fracture. How will you classify this fracture/

a. Traumatic fracture
b. Pathological fracture
c. Stress fracture
d. None of the above

Q4

- A football player twisted his ankle when his foot got stuck in the ditch on the ground. The foot was fixed and the whole weight of the body acted on the ankle. If he has swelling and tenderness on the lateral side of ankle. What kind of fracture do you expect in the fibula?

a. Transverse fracture
b. Spiral fracture
c. Oblique fracture
d. Communited fracture

Q5

While doing a closed nailing in a case of closed fracture shaft of femur what kind of healing do you expect in this case?

a. Direct healing
b. Indirect healing
c. Combination of direct and indirect healing
d. None of the above