Bone Tissue

Consists mainly of connective tissue:

- ✓ **widely scattered bone cells surrounded by an abundant matrix.**

The matrix:

- ✓ **25% water**
- ✓ **25% collagen fibers**
  - ➢ **Accounts for the bone's flexibility**
- ✓ **50% crystallized minerals**
  - ➢ **Mainly $CaPO_4$ and $CaCO_3$**
  - ➢ **Fills in around the collagen fibers**
  - ➢ **Accounts for the bone's hardness**

Bone Growth and Repair

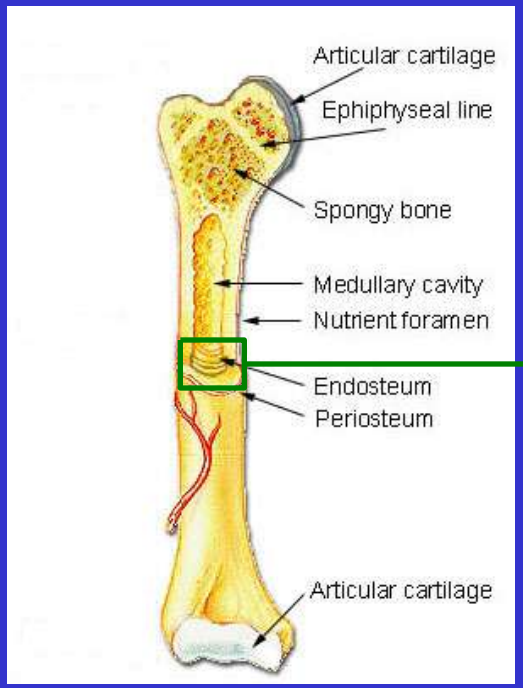
- ***Ossification*** **or** ***Osteogenesis***
  - formation of bone
  - continuous process

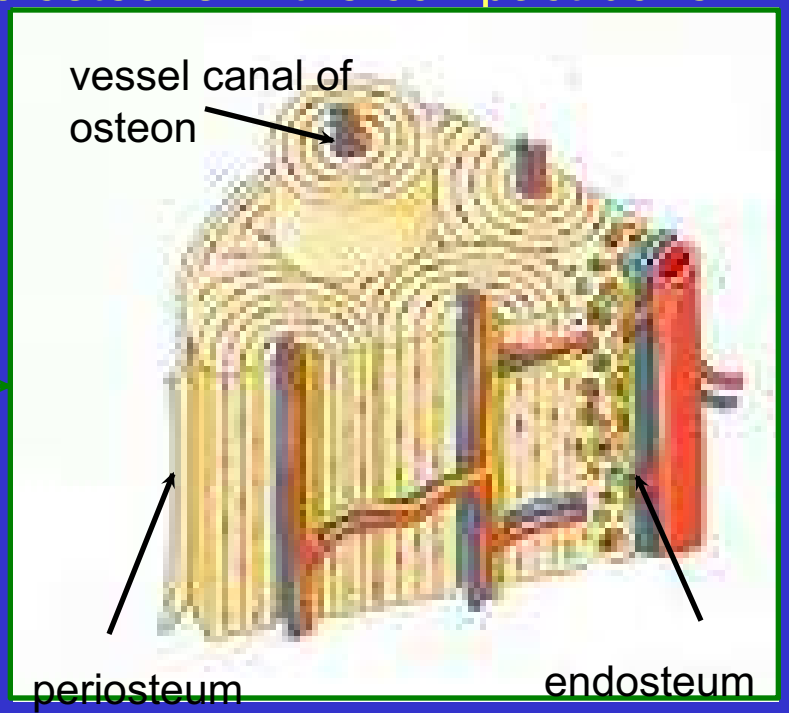
- **4 types of cells involved in the growth of bones:**

1) osteoprogenitor cells
2) osteoblasts
3) osteocytes
4) osteoclasts

Osteoprogenitor Cells

- Unspecialized stem cells found in
  - the periosteum,
  - the endosteum (membrane that surrounds the medullary cavity),
  - and the vessel canals of the osteons in the compact bone.





They are the only bone cells to undergo cell division. The resulting daughter cells develop into osteoblasts.

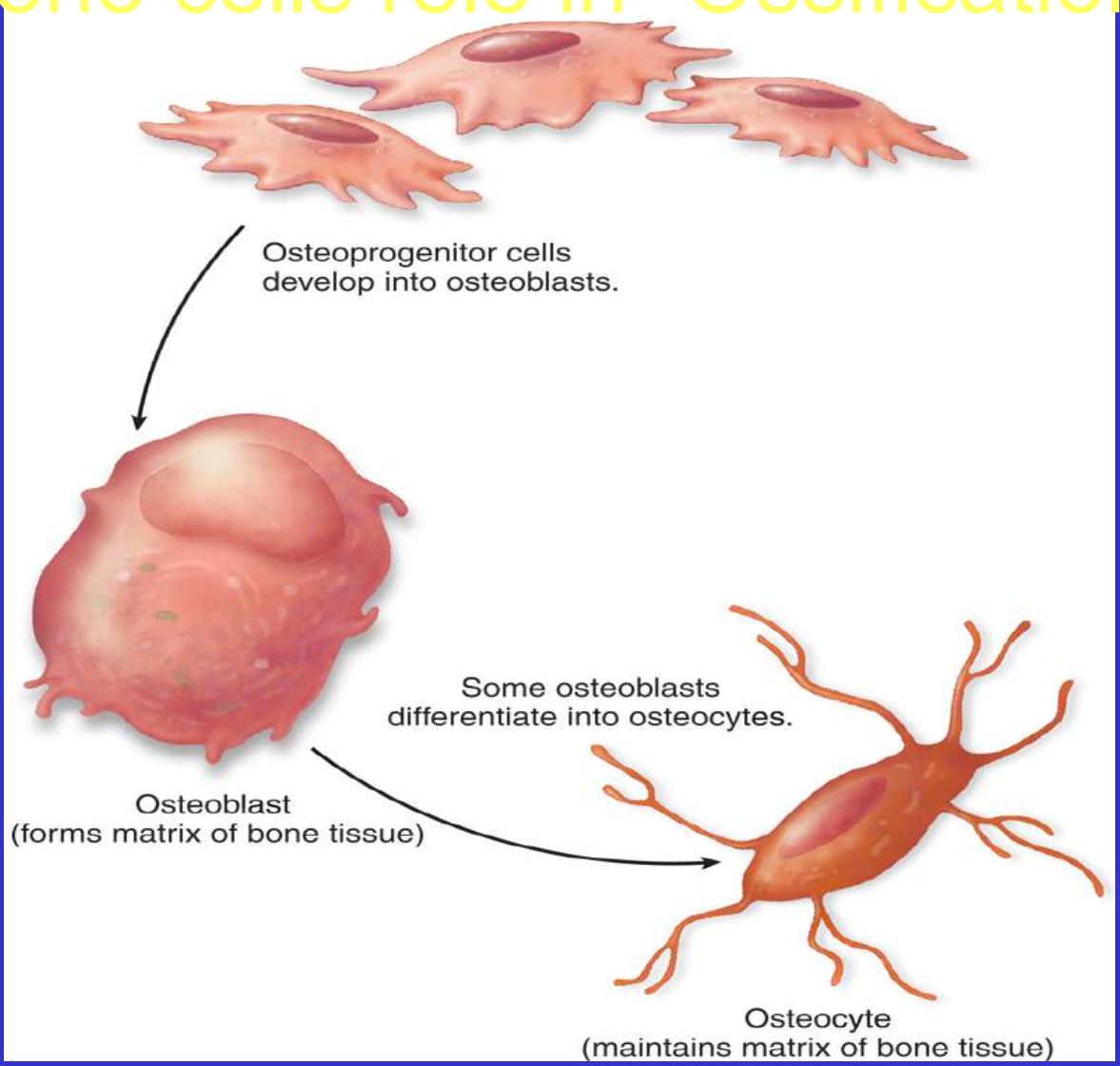
Osteoblasts

- Arise from *osteoprogenitor* cells.
- "Bone-Building" cells
  - Secrete the collagen fibers and other organic compounds and inorganic minerals that make up the bone matrix (discussed previously)
  - Initiate calcification (hardening of the bone)
- Do not undergo cell division.
- Convert to *osteocytes* when trapped in matrix.

Osteocytes

- Derived from *osteoblasts.*
- Considered “mature bone cells.”
- Do not undergo cell division.
- Maintain the bone’s daily metabolism.

Bone cells role in “Ossification”



Ossification

- Begins in the womb and continues throughout life.

- Types:

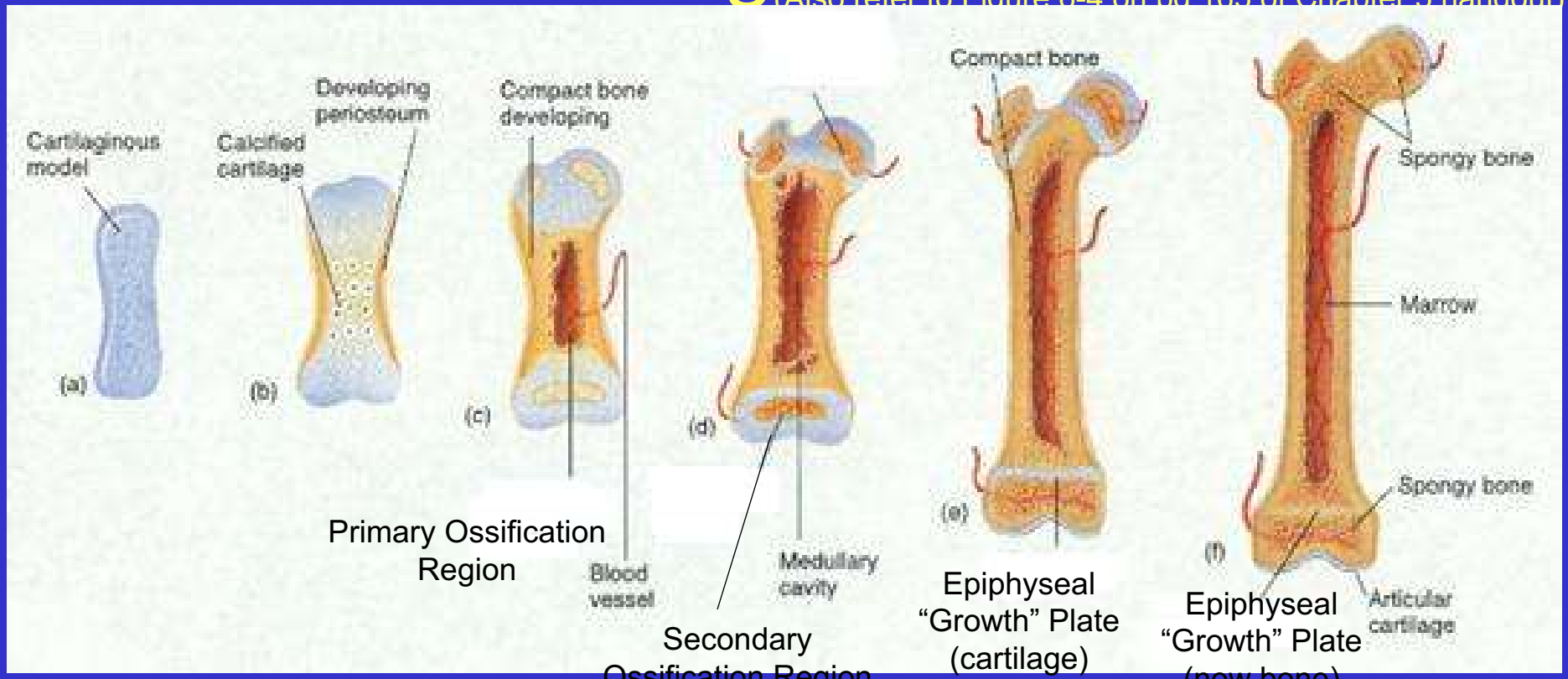
1) Intramembrous ossification
   - ✓ bone develops between 2 membranous sheets

   e.g. skull development

2) Endochondral ossification
   - ✓ *endo* - within; *chondral* – cartilage
   - ✓ bone formation in the majority of the skeletal bones
   - ✓ Shaped cartilage is replaced with bone

Endochondral Ossification of the Long Bone

(Also refer to Figure 6-4 on pg 165 of Chapter 5 handout)



Once the growth plate scars over, the length and width of the bone can no longer increase; however, ossification never stops.

Hormones control the growth of bones.

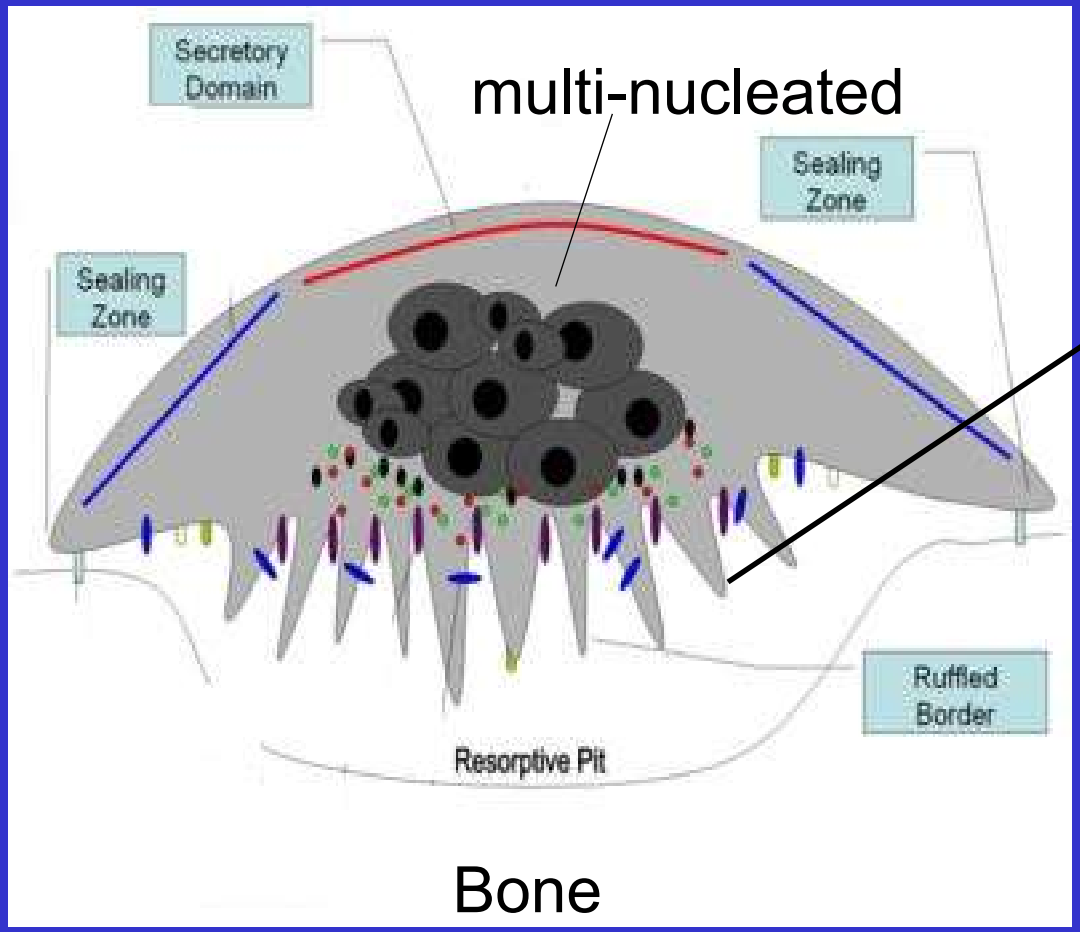
Osteoclast

- Not only is bone constantly being built up, the body must also be able to tear down old bone.
  - This is the function of the *osteoclast*.
  - Known as ***resorption:*** breakdown of bone matrix
- Osteoclasts originate from the fusion of as many as 50 WBC's called monocytes found in the red bone marrow.
- Osteoclasts help move calcium and phosphate into the blood stream.

Remember: osteoblast = build-up

osteoclast = break-down

Osteoclast



Secretes:

✓ lysozymes to destroy the collagen

✓ acids to dissolve the minerals

Bone Remodeling

- Ongoing process of resorption and ossification occurs simultaneously:
  - Osteoclasts carve out tunnels in old bone tissue
  - Osteoblasts build new bone to fill in that tunnel.

- Smaller bones undergo complete turnover approximately every 2 months; larger bones take longer *(actual times vary between sources)*

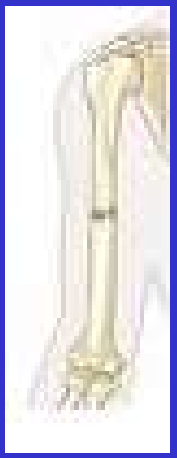
2 Purposes of Bone Remodeling

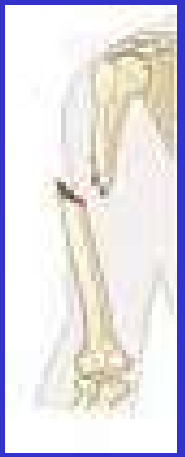
Renews bone tissue before deterioration sets in.

Redistribute bone matrix along stress lines.

Bone Fractures

- **What is a fracture?**
  - A fracture is a partial or complete break in the bone.
  - When a fracture occurs, it is classified as either:
    1) **simple (closed) fracture** - the bone is broken, but the skin is intact.
    2) **compound (open) fracture** - the bone exits and is visible through the skin, or where a deep wound exposes the bone through the skin.





Common Types of Fractures

hairline fracture:

A fine fracture that does not completely break or displace the bone; appears on x-ray as a hair

spiral fracture:

A fracture caused by a severe twisting of the bone; runs around axis of bone

Common Types of Fractures

greenstick fracture:

An incomplete break; more common in children because of softer bones.

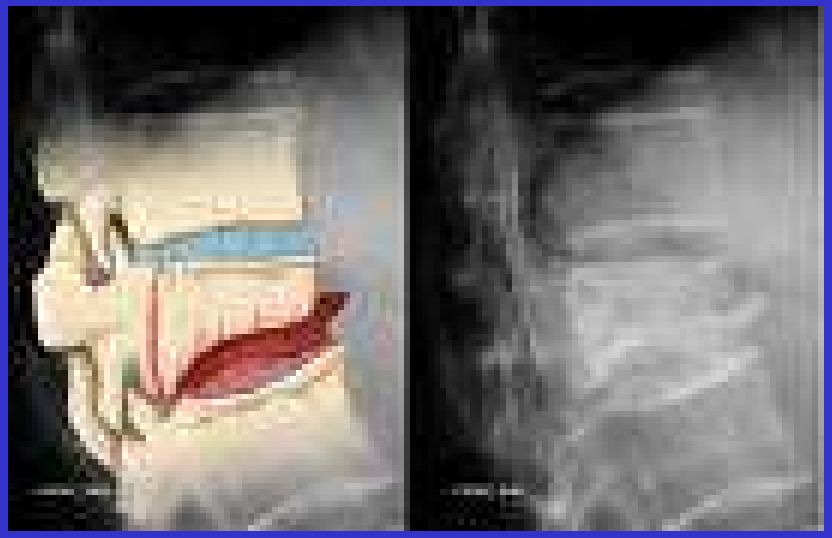
comminuted fracture:

A bone is crushed to the point it becomes fragmented into 3 or more pieces.

Common Types of Fractures

compression fracture:

A bone is compressed usually due to disease or trauma.



stress fracture:

Incomplete fracture due to repetitive stress such as in athletics or disease. Most commonly a hairline fracture or fractures of weight-bearing bones such as the tibia (lower leg) or metatarsals (foot). Often missed on an x-ray but seen in a bone scan.

Treatment of Fractures

Bones can heal normally only if the ends of the bones are aligned.

1st -- Must be ***set*** (*reduced*) if not aligned:

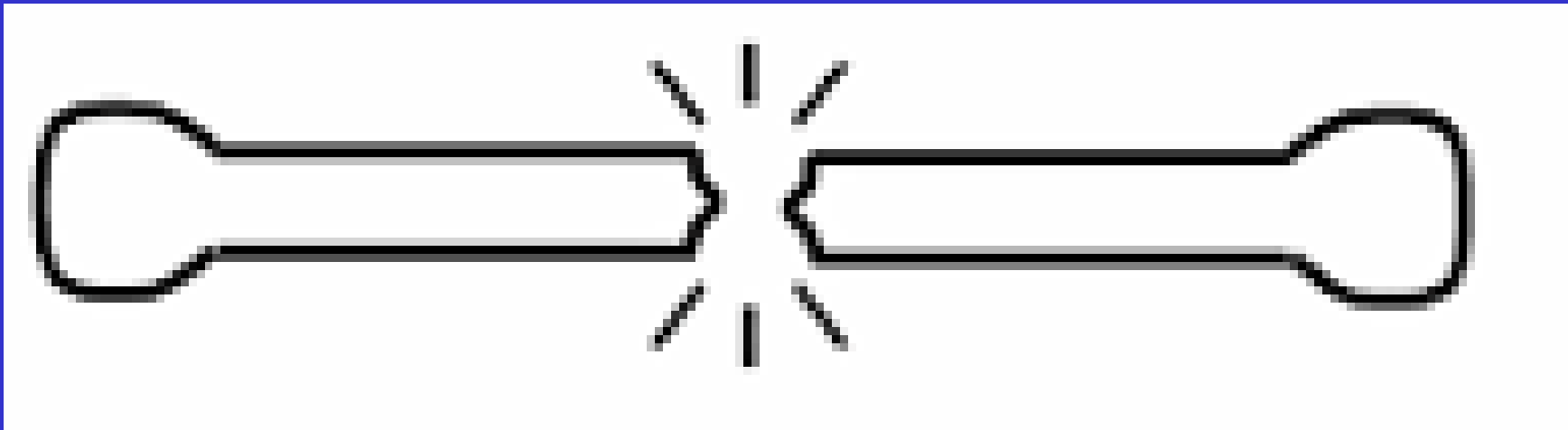
- ✓ ***Closed Reduction:*** force is exerted on the broken bone to bring the bones into alignment.
- ✓ ***Open Reduction or Surgical Reduction*** is required requiring pins, screws, plates, etc. to align bones.

2nd -- Must be immobilized with a splint or cast.

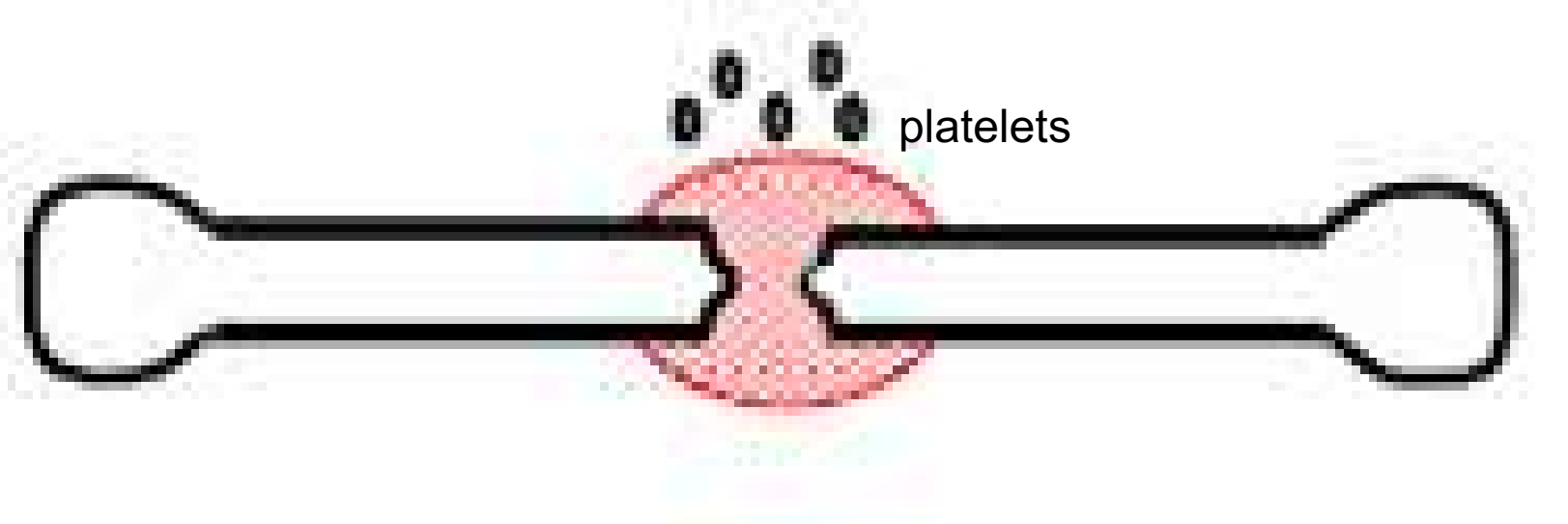
Traction: use of weights exerting a pulling force on fractured long bones keeps them in place and allows healing.

Bone Repair

The following steps occur in the repair of a fractured bone.

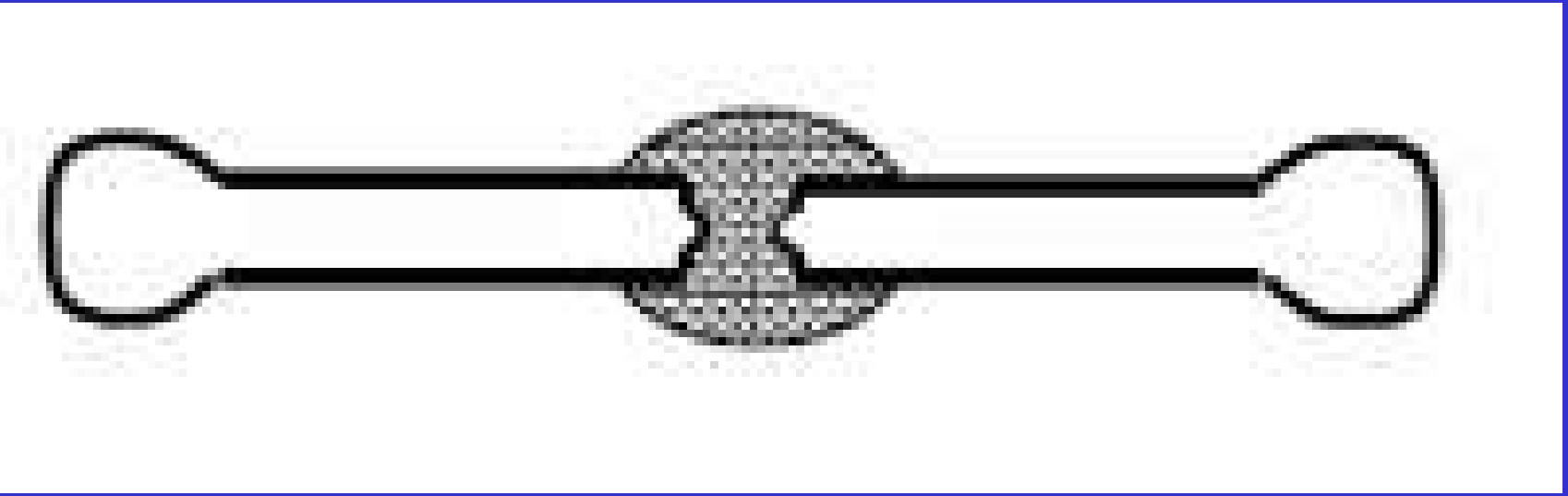


Bone Repair Step 1: Formation of "*fracture hematoma*"



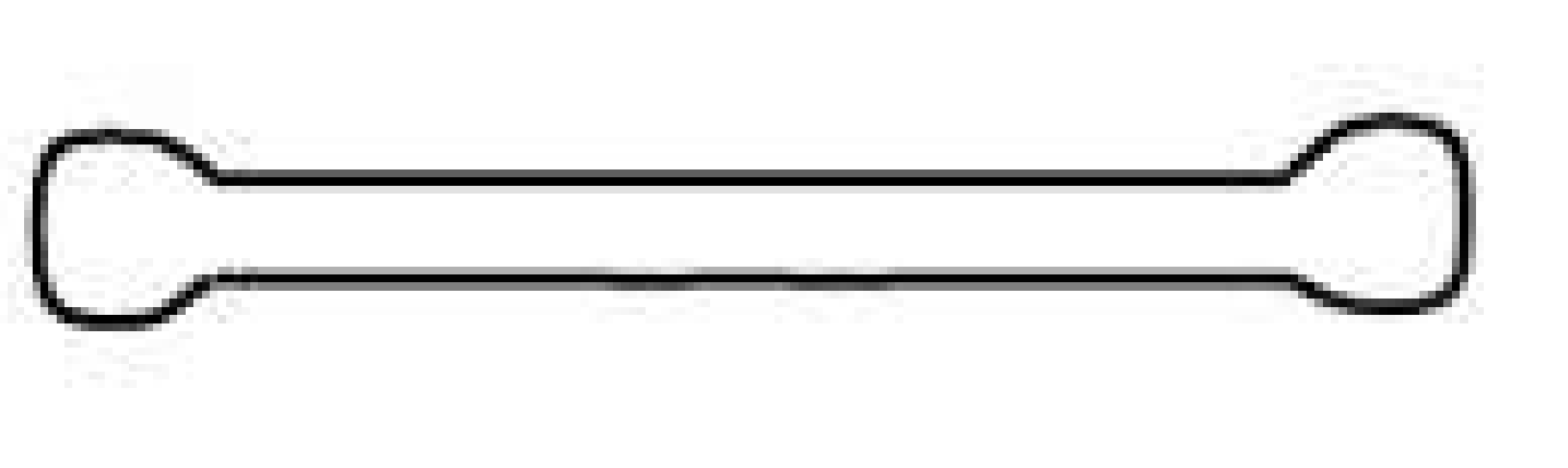
- ✓Blood leaks and clots at fracture site 6-8 hrs after injury.
- ✓New capillaries grow into the clot.
- ✓Phagocytes (WBC's) remove dead blood cells and osteoclasts remove dead bone tissue.
- ✓Can last up to several weeks.

Bone Repair Step 2: Formation of "bony *callus*"



- ✓Ossification occurs:
  - Osteoprogenitor cells produce osteoblasts.
  - Osteoblasts produce matrix and mineralization occurs to bridge the broken ends of the bone.
  - Osteocytes form in the matrix.
- ✓Lasts from 1-4 months

Bone Repair Step 3: Bone Remodeling



✓Compact Bone replaces spongy bone around perimeter of fracture.

✓Normal simultaneous ossification and resorption occurs.

✓Usually >4 months; severely broken bones will take longer due to reduced blood supply.

A healed bone is as strong or stronger than before the fracture.