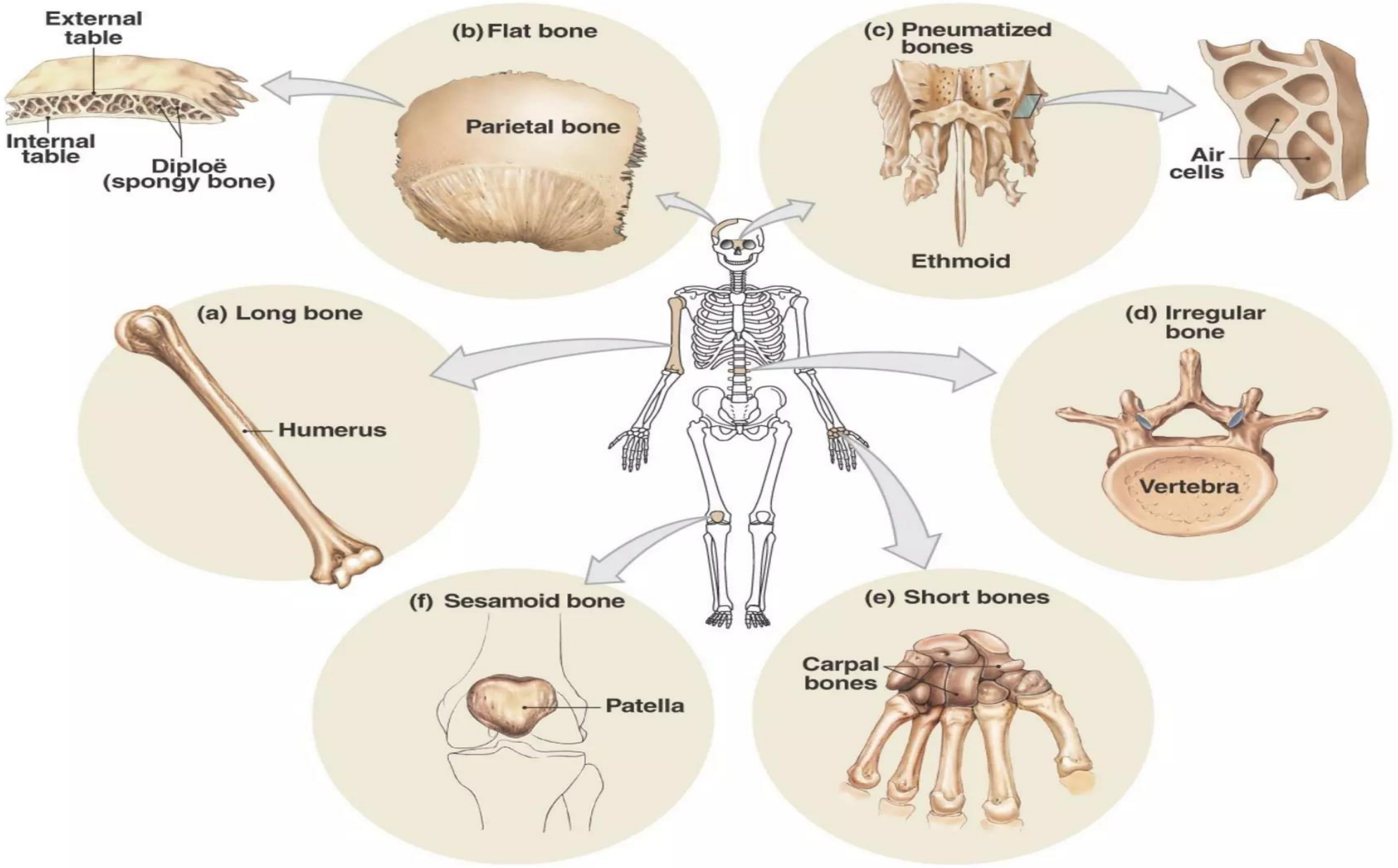
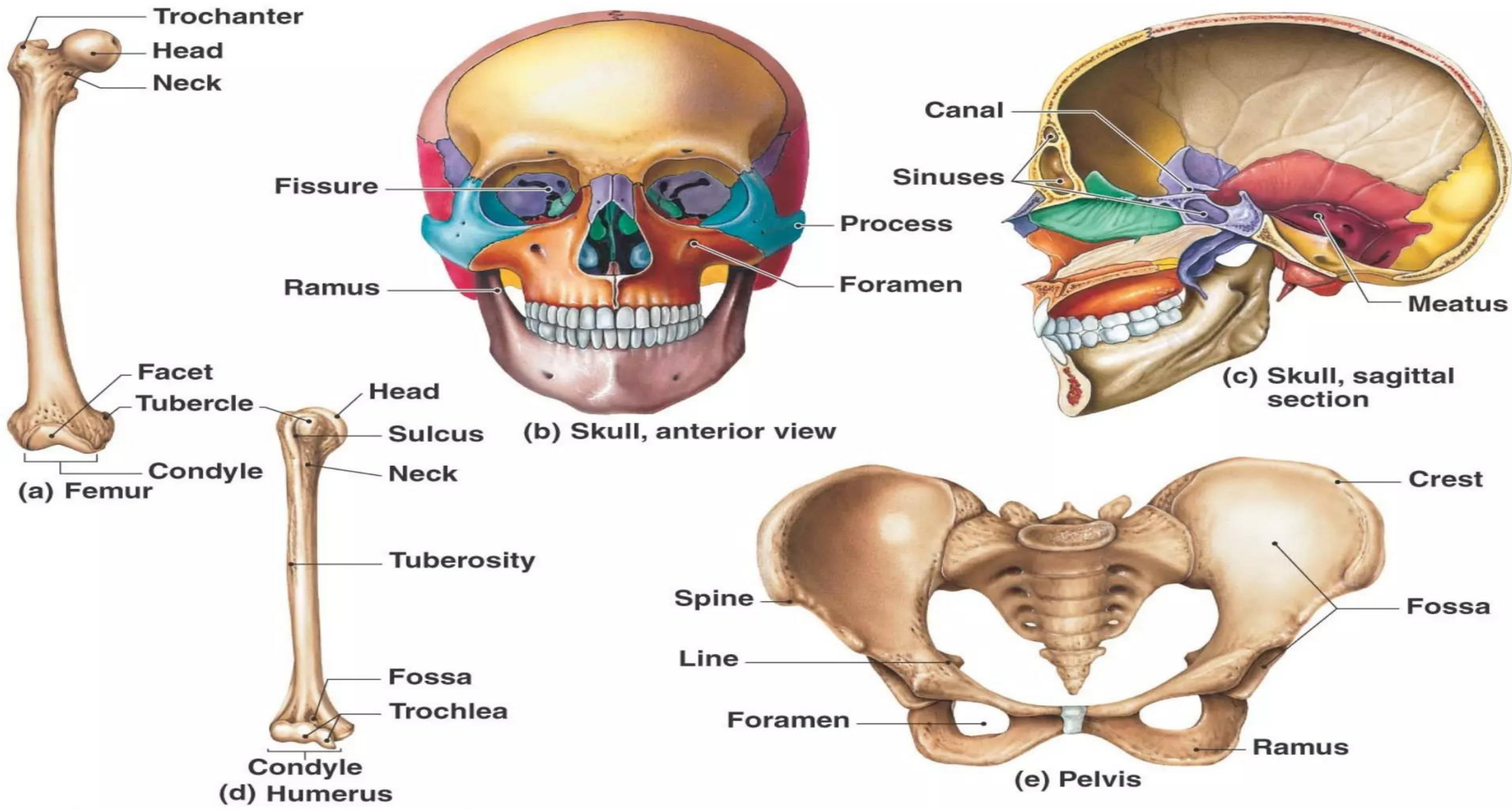
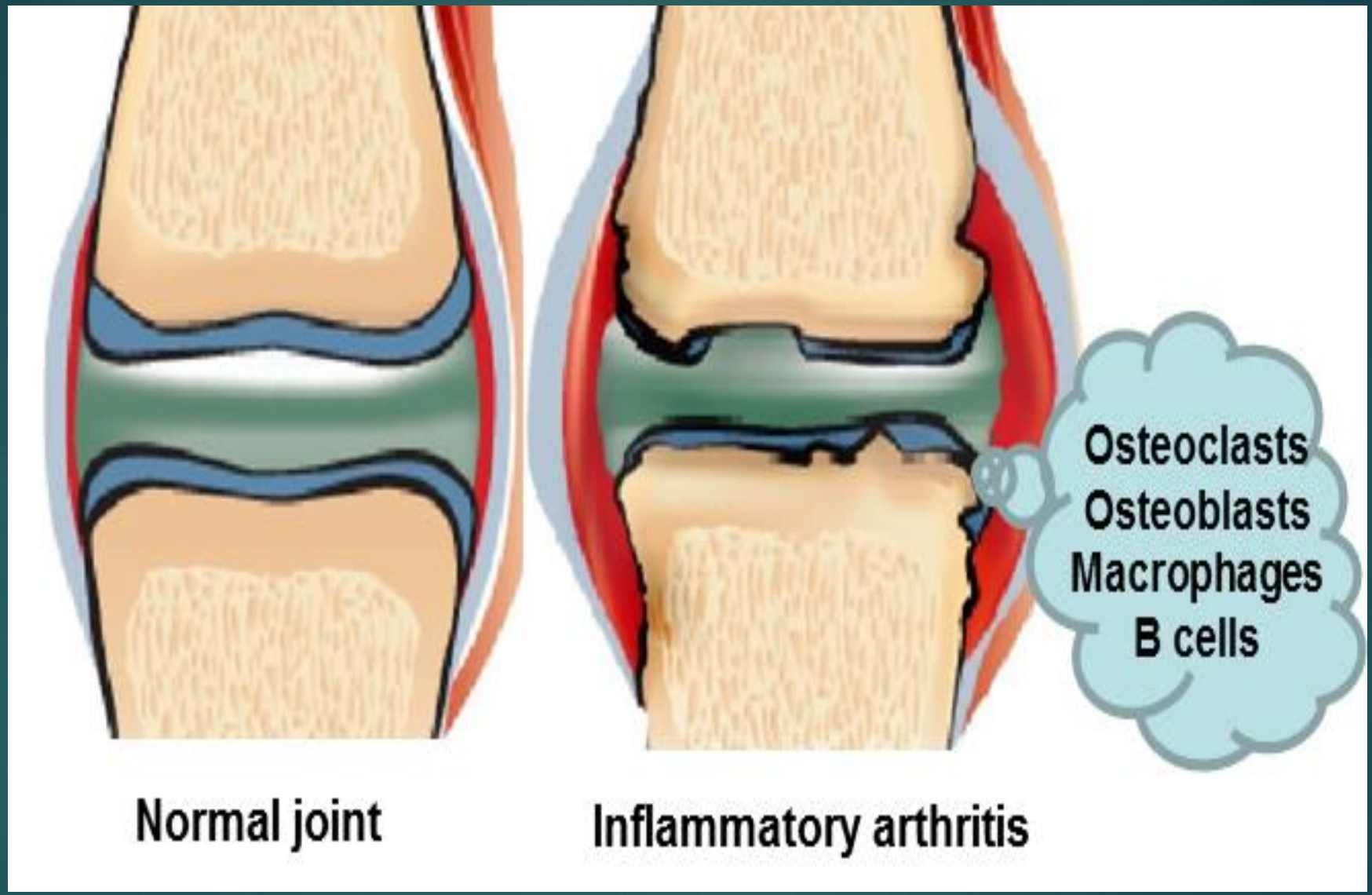
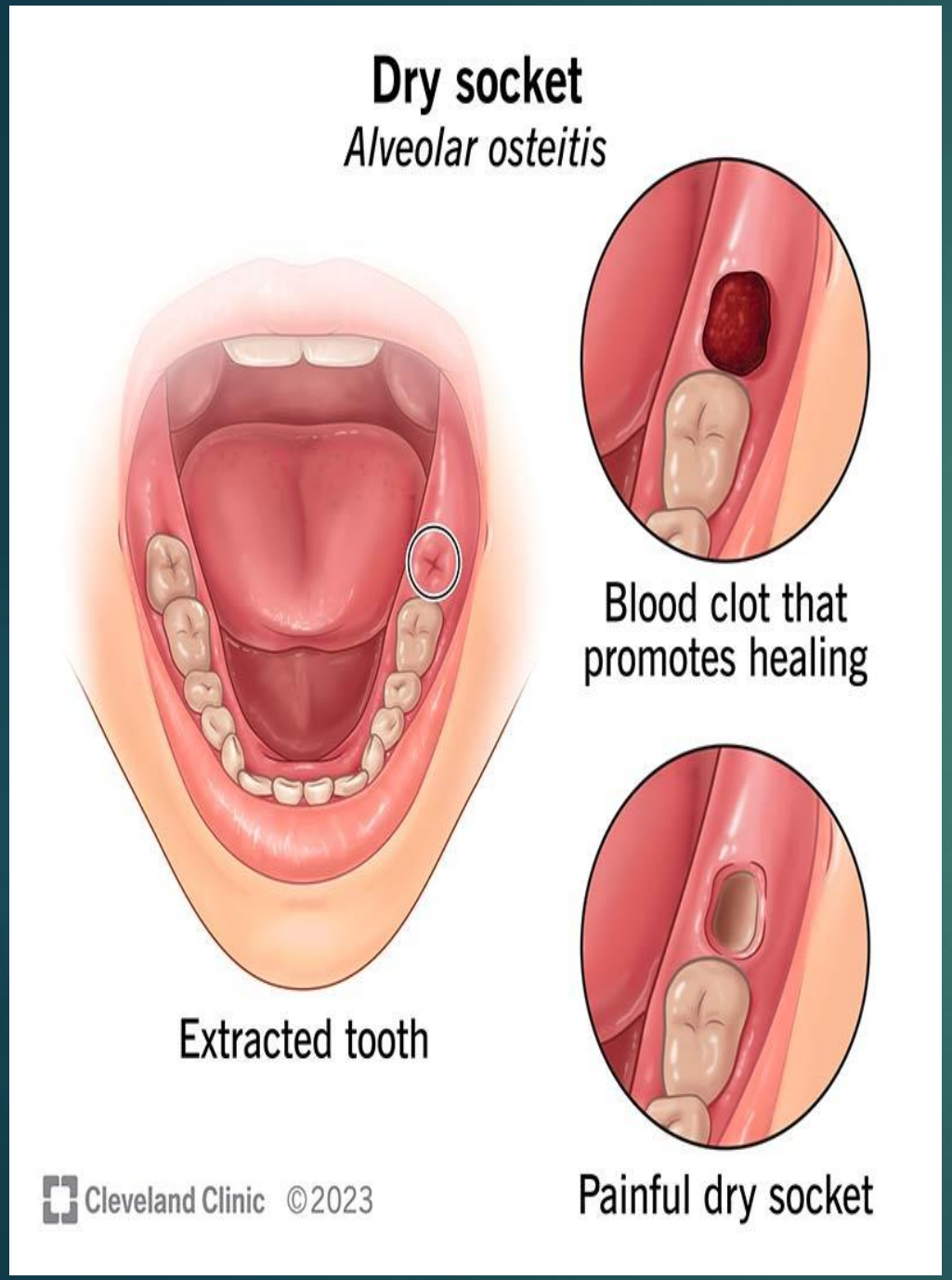




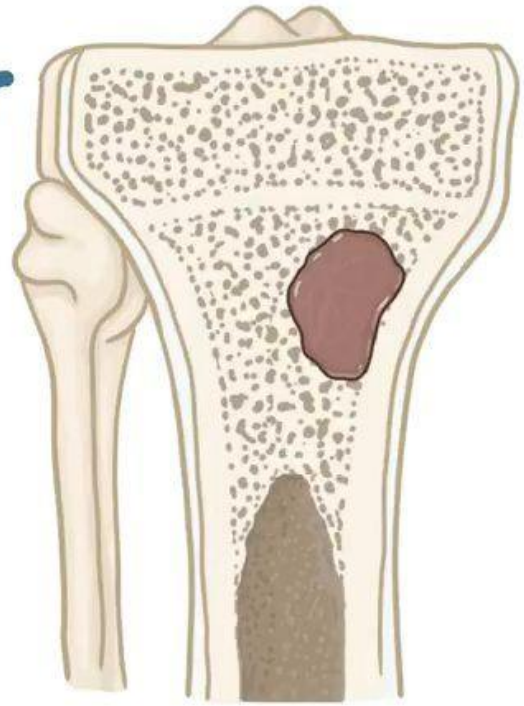

Osteoclasts
Osteoblasts
Macrophages
B cells
Normal joint
Inflammatory arthritis

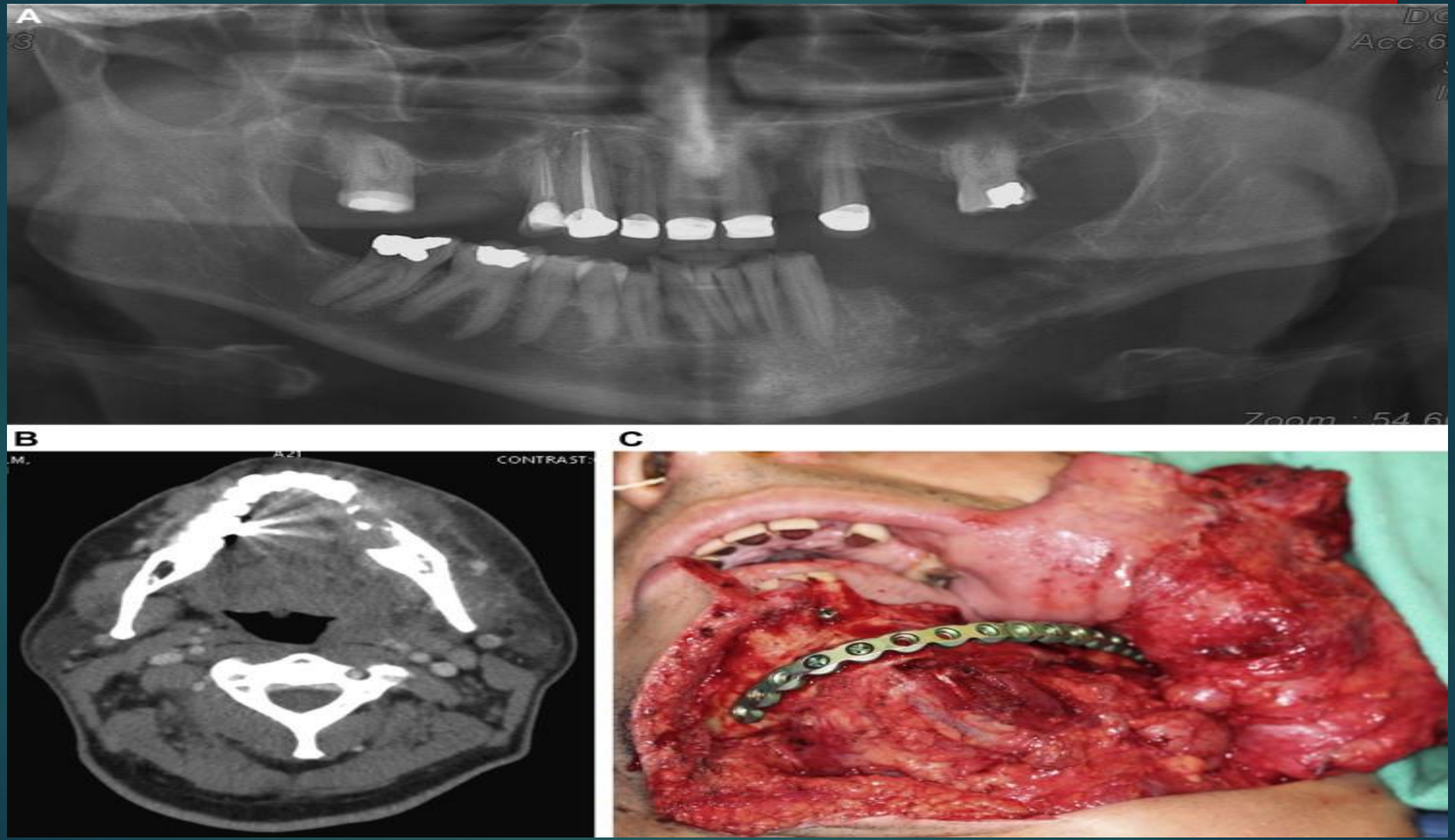

Dry socket
Alveolar osteitis
Blood clot that promotes healing
Extracted tooth
Painful dry socket
Cleveland Clinic ©2023

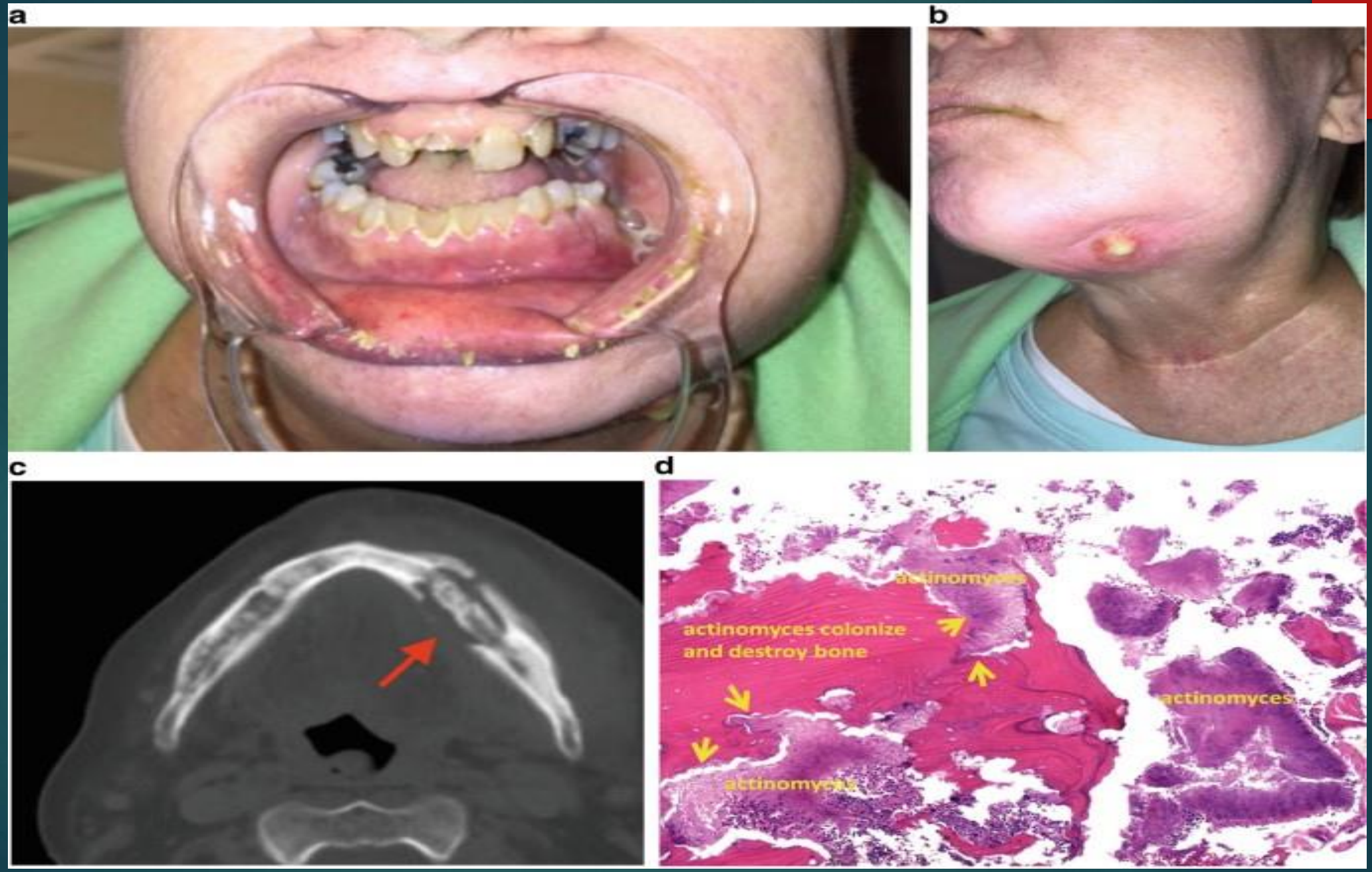
OSTEOMYELITIS

BONE — BONE MARROW — INFLAMMATION

* INFLAMMATION of the BONE or BONE MARROW
  - ↳ RESULTS from an INFECTION




A
B
CONTRAST
C


a
b
c
d
actinomyces colonize
and destroy bone
actinomyces
actinomyces
actinomyces

Bone Tissue

Skeletal System Fun Facts

- Hyoid bone, in your throat is the only bone not attached to any other bone
- The bone broken most often in the collarbone (clavicle)
- Did you know that there are 206 bones in the adult human body and there are 300 in children (as they grow some of the bones fuse together).
- Over a period of about seven years, each bone in our body is slowly replaced until it is a new bone.
- Every second, our bone marrow produces two million red blood cells.
- Over half the body's bones are in the hands and feet.

Bone and Osseous Tissue

- Connective tissue with a matrix hardened by minerals (calcium phosphate)
- The hardening process is called mineralization or calcification
- Osseous tissue in only one tissue that make up bone. Also, bone marrow, blood, cartilage, nervous tissue, adipose tissue & fibrous connective tissue
- Bone can mean: structure or osseous tissue.

- Anormal range of total blood calcium in adults is usually between 8.5 and 10.3 milligrams/deciliter (mg/dL).
- A normal ionized calcium level generally ranges between 4.6 to 5.3 mg/DI.
- Normal range is 44 to 147 international units per liter (IU/L) or 0.73 to 2.45 microkatal per liter (µkat/L).
- Normal values may vary slightly from laboratory to laboratory.
- They also can vary with age and sex.

- Alkaline phosphatase forms a large family of dimeric enzymes, usually confined to the cell surface.
- Hydrolyzes various monophosphate esters at a high pH optimum with release of inorganic phosphate.

- **Calcium function in body:**

•Building strong bones and teeth.
•Clotting blood.
•Sending and receiving nerve signals.
•Squeezing and relaxing muscles.
•Releasing hormones and other chemicals.
•Keeping a normal heartbeat

Function of Skeleton

1.Support: Bones of legs, pelvis, vertebral column

2.Protection: Bones enclose and protect the brain, spinal cord, Heart, lungs, pelvic visera

3.Movement: Limb movement and breathing

4.electrolyte balances:

Stores Ca^{+} and P^{+} ions and releases them as needed

5.acid-base balance:

buffers the blood against excessive pH changes by absorbing or releaseing alkalilne salts

6.blood formation:

major producer of blood cells, including blood cells of the immune system

Shapes of Bones

Bones are classified 4 groups depending upon their shape and functions:

1. Long Bones
2. Short Bones
3. Flat Bones
4. Irregular Bones

Histology of Osseous Tissue

Bones consists of:

Cells, fibers, and ground substance

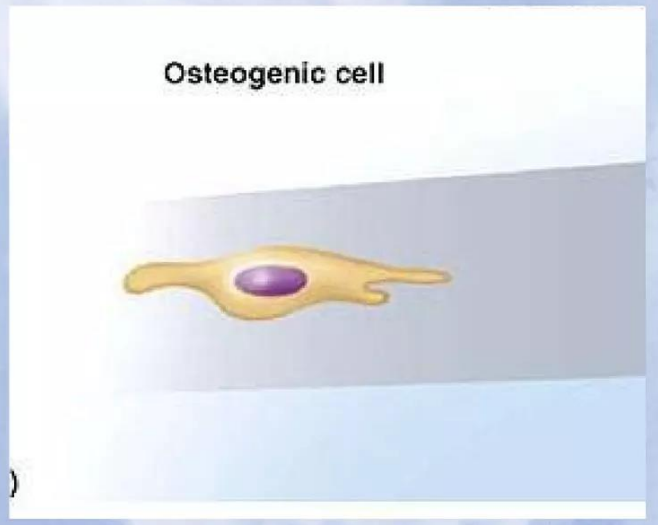
4 Principle types of bone cells:

1. **Osteogenic cells**
2. **Osteoblasts**
3. **Osteocytes**
4. **Osteoclasts**

Histology of Osseous Tissue

1. Osteogenic Cells

- Stem cells that give rise to most other bone cells
- Found in the endosteum layer, inner layer of the periosteum and central canal
- Multiply continually!



Histology of Osseous Tissue

2. Osteoblasts

- Are BONE FORMING cells
- Cuboidal, single layer in endosteum and periosteum
- Synthesis soft organic matter of bone matrix, which then hardens by mineral deposition.

Stress or fractures stimulates osteogenic cells to multiply rapidly and differentiate into osteoblasts in order to lay down more bone, to rebuild and reinforce.

Histology of Osseous Tissue

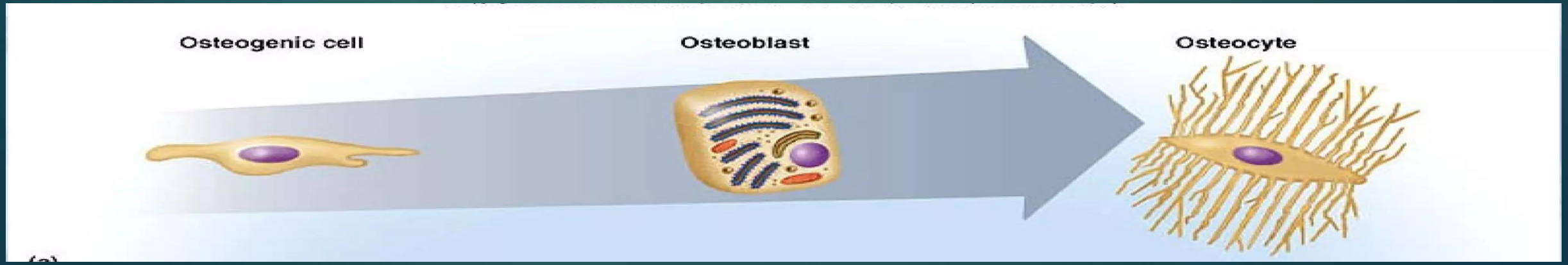
3. Osteocytes

- Are osteoblasts that have become caught in the matrix they deposited.

- Reside in lacunae

- connected to each other by slender channels called canaliculi

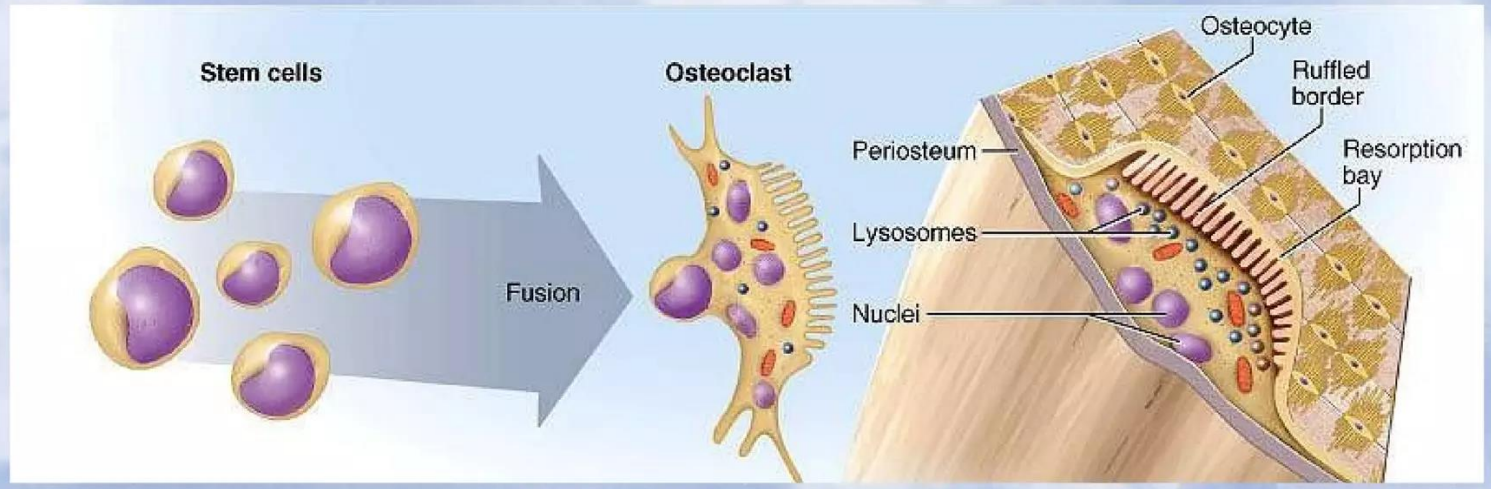
- Each Osteocyte is connected to the next by gap junctions in order to pass nutrients, chemical signals to one another, and waste to the nearest blood vessel for removal.



Histology of Osseous Tissue

4. Osteoclasts

- Are **BONE DISSOLVING** Cells
- arise from TOTALLY different cell lineage
- develop from bone marrow stem cells
- fusion of several stem cells, therefore large
- 3-4 nuclei, ruffled border, resorption bays



Matrix of Osseous Tissue

- Dry weight = **1/3 organic and 2/3 inorganic matter**

- Organic matter
  - **Produced by osteoblasts**
  - **collagen, glycosaminoglycans, proteoglycans and glycoproteins**

- Inorganic matter
  - **85% hydroxyapatite (calcium phosphate salt)**
  - **10% calcium carbonate**
  - **other minerals (fluoride, potassium, magnesium)**

- Combination provides for strength and resilience
  - **minerals resist compression; collagen resists tension**
  - **bone adapts by varying proportions**

Histology of Compact Bone

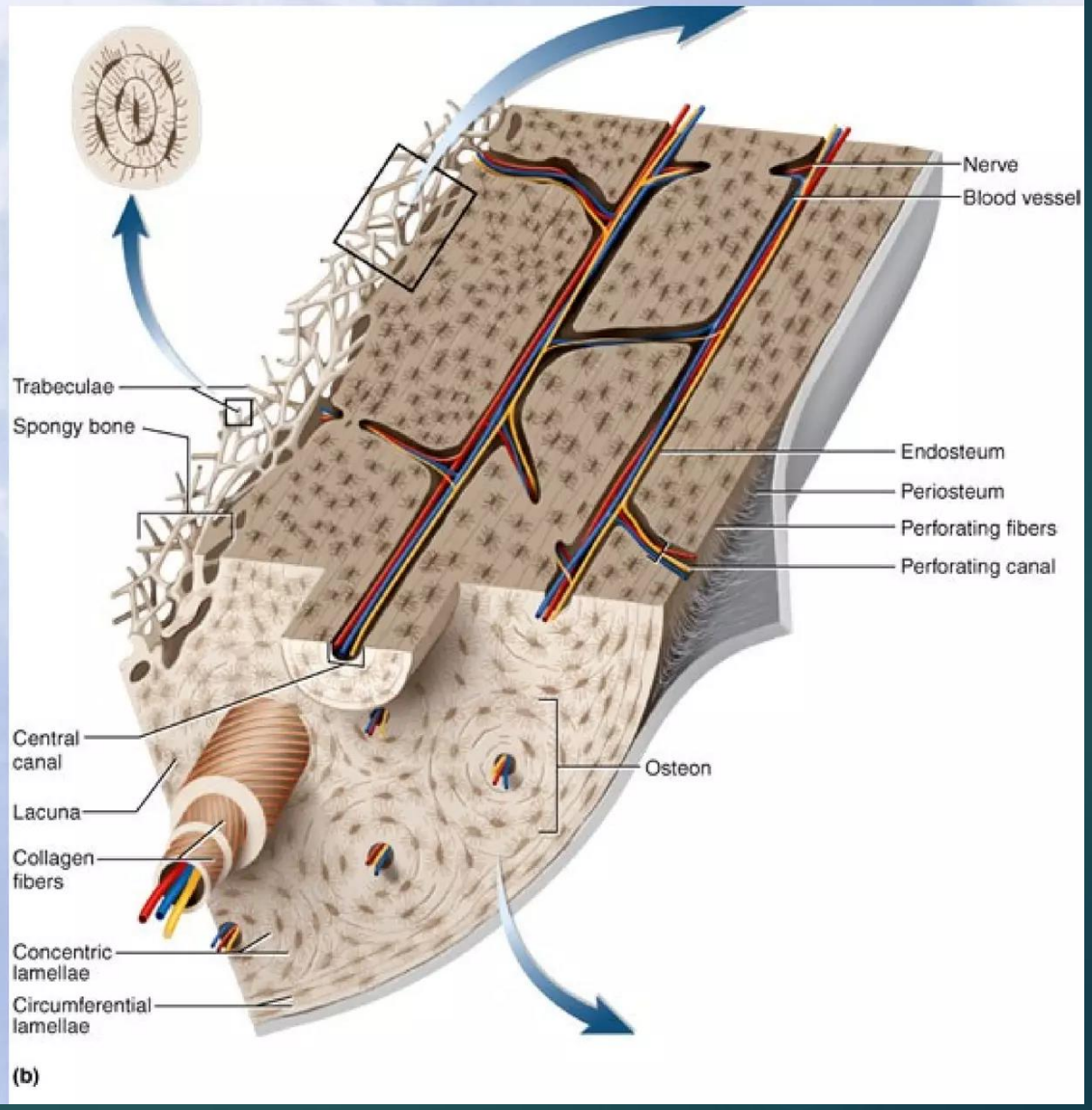
Histological slides show:

- *Concentric lamellae-* matrix around *Central canals (haverian canals)*

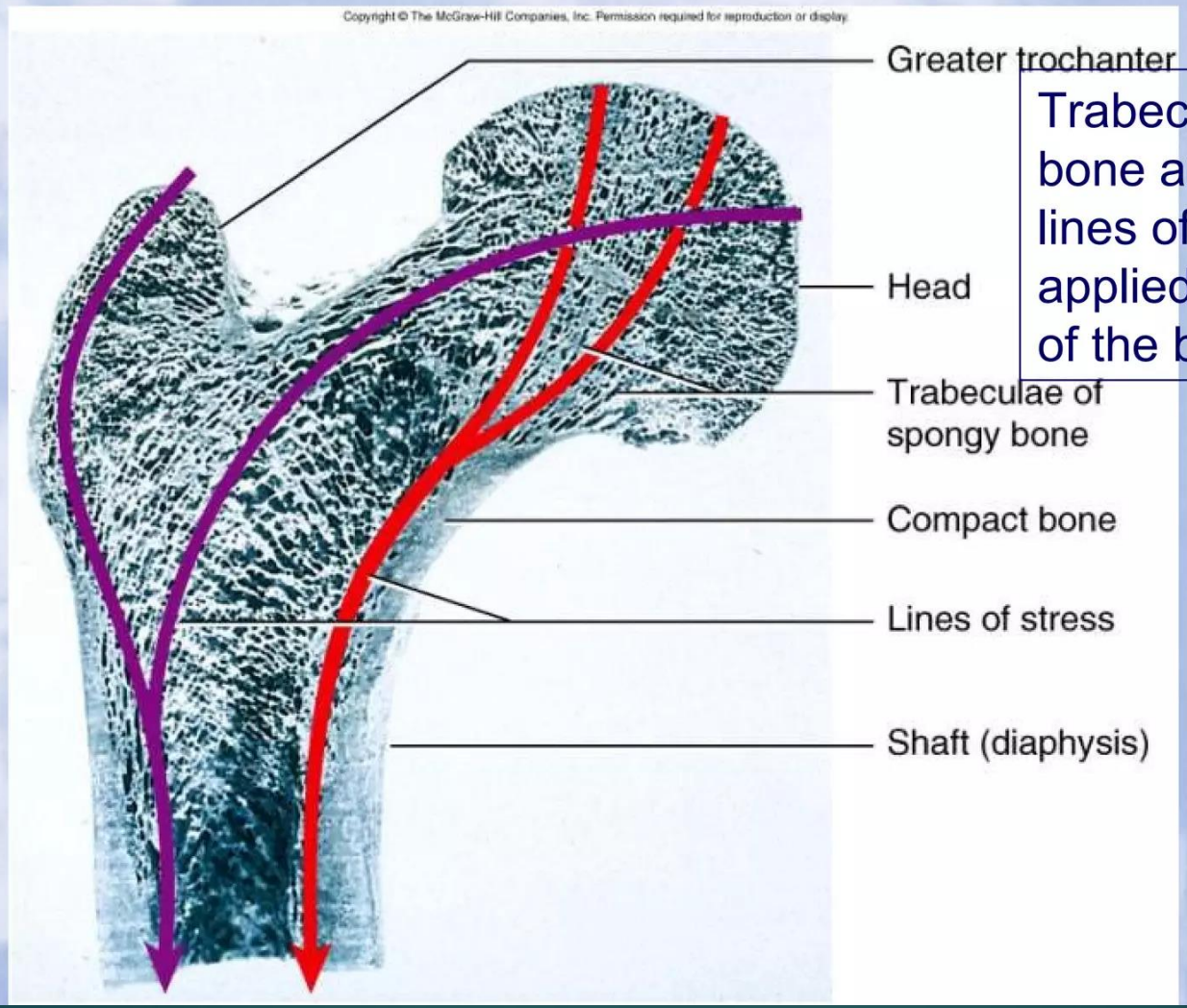
- ***Osteon***- (basic structural unit) a central canal and it's lamellae

- Collagen fibers- "corkscrew" down the matrix, alternating direction. This will increase strength of bone.

- Perforating (Volkmann) canals- nutrient foramen that allow blood vessels and nerves to enter the bone.



Spongy Bone Structure and Stress



Trabeculae of spongy bone are aligned along lines of mechanical stress applied by the weight of the body.

Bone Marrow

- General term for soft tissue found in medullary cavity (long bone) and among trabeculae (spongy bone)

2 Types:

1. Red marrow like thick blood
   - Children almost every bone has red bone marrow = hemopoietic tissue
   - reticular fibers, immature cells, scattered adipocytes
   - in adults: vertebrae, ribs, sternum, pelvic girdle and proximal heads of femur and humerus

1. Yellow marrow
   - fatty marrow of long bones in adults

What would be the most acceptable place to draw red bone marrow from an adult?

Bone Development

Called Ossification or Osteogenesis;

2 Types:

1. Intramembranous Ossification- produce the flat bones of the skull and most of the clavicle. These bones develop within a fibrous sheet, similar to the dermis.

2. Endochondral Ossification- bone develops from hyaline cartilage. Vertebrae, ribs, sternum, scapula, pelvis and limb bones.

Calcium & Phosphate Homeostasis

Skeleton keeps reservoir of Ca and P mineral.

- When the supply is ample they are deposited in the skeleton
- Withdrawn when they are needed.

Changes in phosphate levels = little effect

Changes in calcium levels = serious

Normal blood concentration of Ca is 9.2 – 10.4 mg/dl

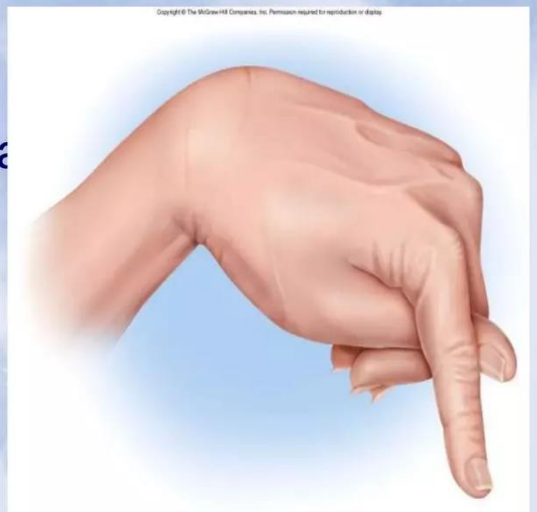
- Below 9.2 is called Hypocalcemia
- Above 10.4 is called Hypercalcemia

Calcium & Phosphate Homeostasis

Hypocalcemia- Blood calcium deficiency

Signs:

- Increase nervous system excitability which will lead to muscle spasms, tremors, and tetany
  - Inability of a muscle to relax
  - Begins when blood [ ] = 6mg/dl
- **Carpopedal spasm**: tetany of hand and feet
- **Laryngospasms:** muscles of the larynx contra



Calcium & Phosphate Homeostasis

Hypocalcemic Excitability:

Reason:

Excitable tissue such as nerves use both positive and negative charged ions in order to become excited (Na channels).

With less calcium, sodium channels open more easily, sodium enters cell and excites neuron.

Calcium & Phosphate Homeostasis

Hypercalcemia- Excess blood calcium

Signs:

- At 12mg/dl, nerves and muscle become less excitable.
- Depression of the nervous system.
- Muscle weakness
- Sluggish reflexes
- Sometimes cardiac arrest

Reason:

- Ca binds to cell surface makes sodium channels less likely to open, depressing nervous system

Calcitriol (Activated Vitamin D)

Form of Vitamin D produced by sequential action of the skin, liver and kidney.

1. UV light transforms 7-dehydrocholesterol into Vit D.
2. The liver adds an –OH group, converting it to calcidiol
3. The kidney adds another –OH converting to calcitriol (active Vitamin D)

Function of Calcitriol (raise blood calcium concentration)

1. Increases Ca absorption by small intestine (P and Mg ions too)
2. Increases Ca and P resorption from the skeleton.
3. Weakly promotes the reabsorption of Ca ion by kidney, so less is loss in the urine.

Calcitonin

Secreted (C cells of thyroid gland) when calcium blood concentration rises too high

- Lowers blood [ ] by 2 mechanisms:

1. reduces osteoclast activity as much as 70%
2. increases the number and activity of osteoblasts

Parathyroid Hormone (PTH)

Secreted by parathyroid glands (posterior thyroid gland);

Released when blood concentration of calcium is low;

Raises blood [ ] by 4 mechanisms:

1. Stimulates osteoclast population to promote bone resorption;
2. Promotes calcium reabsorption by the kidneys, so less is loss in urine;
3. Promotes final step of calcitriol synthesis in kidneys, thus enhancing the effect of calcitriol;
4. Inhibits osteoblast from producing collagen; thus inhibiting bone deposition.

Types of cartilage: 3

1. Hyaline cartilage: flexible and resilient
   - Chondrocytes appear spherical
   - *Lacuna* – cavity in matrix holding chondrocyte
   - Collagen the only fiber
1. Elastic cartilage: highly bendable
   - Matrix with elastic as well as collagen fibers
   - Epiglottis, larynx and outer ear
1. Fibrocartilage: resists compression and tension
   - Rows of thick collagen fibers alternating with rows of chondrocytes (in matrix)
   - Knee menisci and annunulus fibrosis of intervertebral discs