

**Chapter 6**  
**The Skeletal System:**  
**The Framework**

# Skeletal System Function

- The skeletal system **provides support** and **allows us to move**.
- It protects the soft body parts, produces blood cells, and acts as a storage unit for minerals and fat.
- There are 206 bones in the adult skeleton, along with cartilage, ligaments, and joints.



# Bones

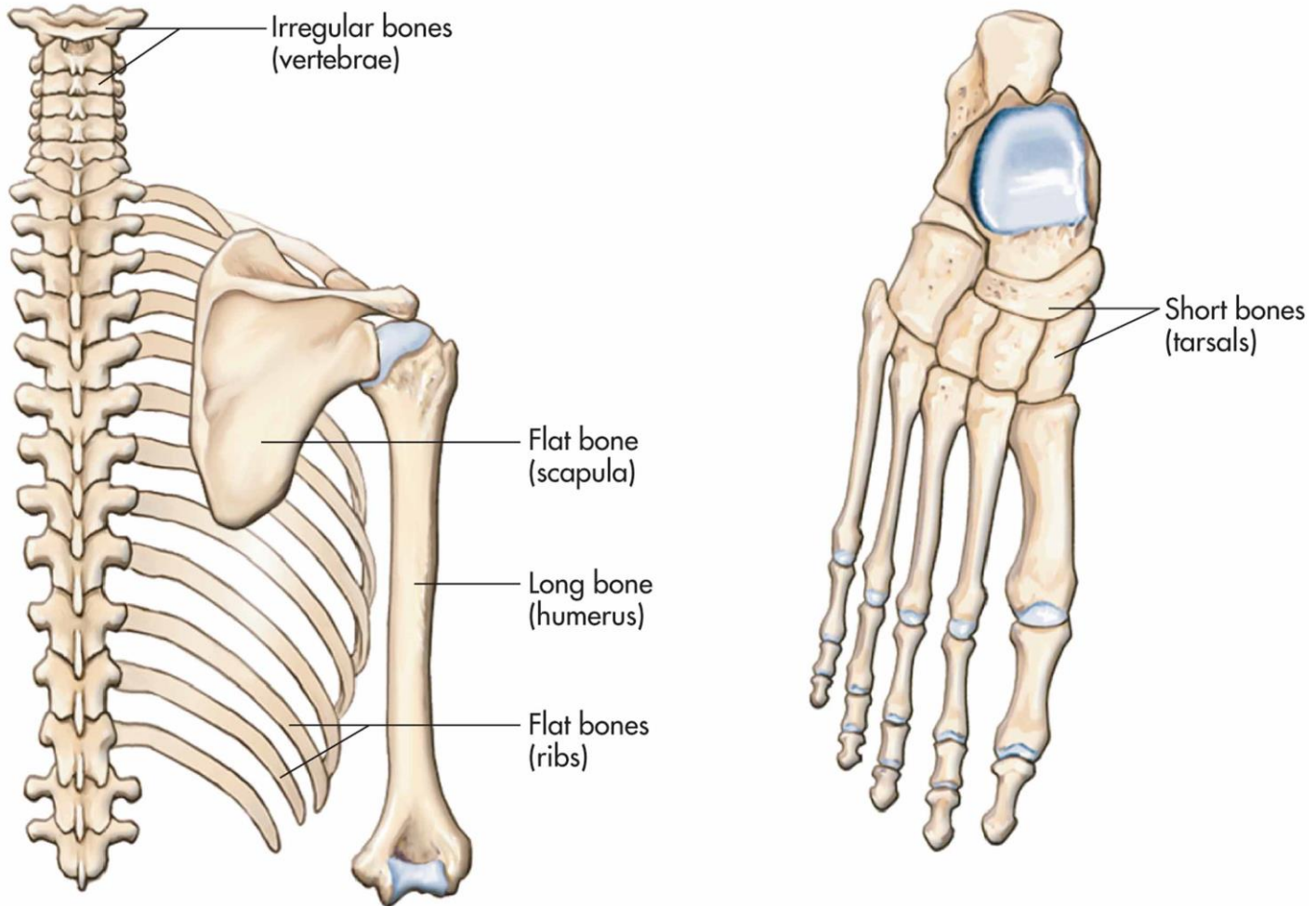
- Although bones are composed of non-living minerals such as **calcium and phosphorous**, they are very much alive.
- The word ‘skeleton’ comes from the Greek meaning “dried up body.”



# Classification of Bones

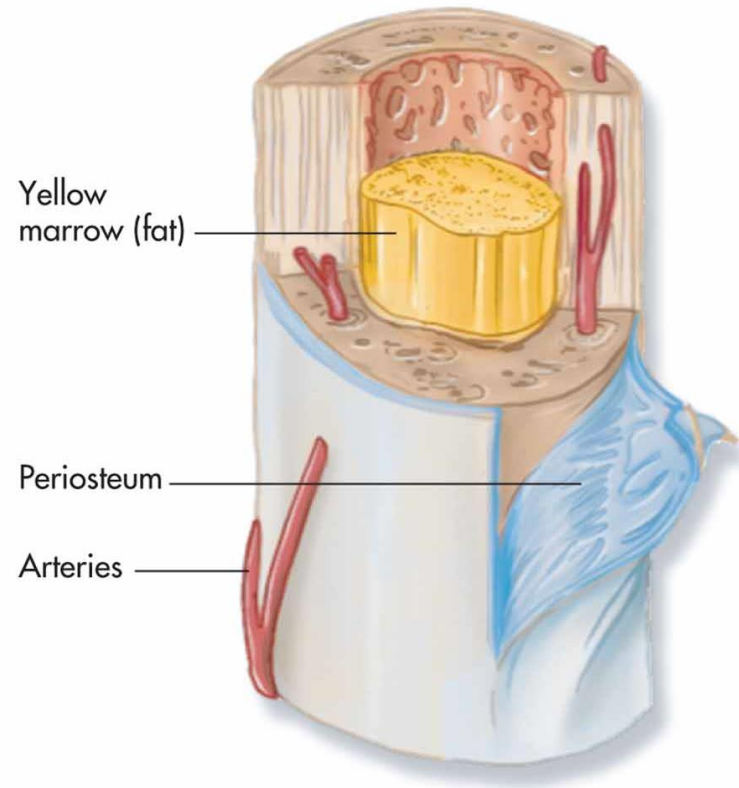
- **Long bones** – These bones are longer than they are wide and can be found in the **arms and legs**.
- **Short bones** – These bones are fairly equal in width and length and are found mostly in the **wrists and ankles**.
- **Flat bones** – These bones are thinner and can be either flat or curved (**skull, ribs, and sternum**).
- **Irregular bones** – These bones are like parts of a jigsaw puzzle, odd in shape, and include the **hip bone and vertebrae**.

# Various Bone Shapes



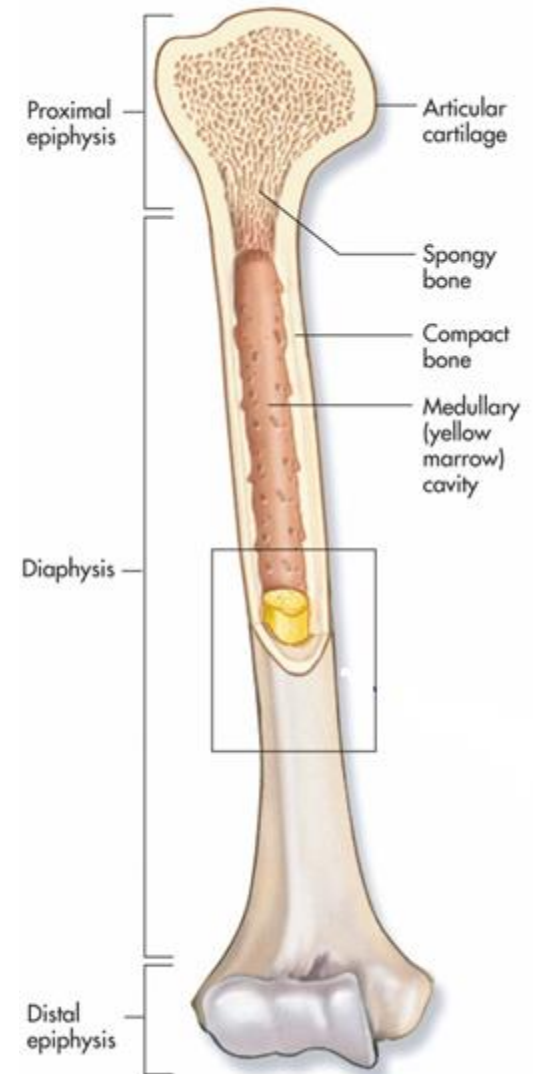
# Basic Bone Anatomy

1. The **periosteum** is an outer covering that is comprised of tough, fibrous connective tissue
  - Contains blood vessels, lymph vessels, and nerves
  - The periosteum acts as an anchor point for ligaments and tendons.



# Basic Bone Anatomy

2. The **epiphysis** is **either end** of a long bone
3. The **diaphysis** is the region between or “running through” the two epiphyses
  - A **hollow cavity** (the medullary cavity). It acts as a storage area for the yellow marrow.
    - Red marrow makes red blood cells
    - **Yellow marrow** has a high fat content and can convert to red marrow in an emergency.

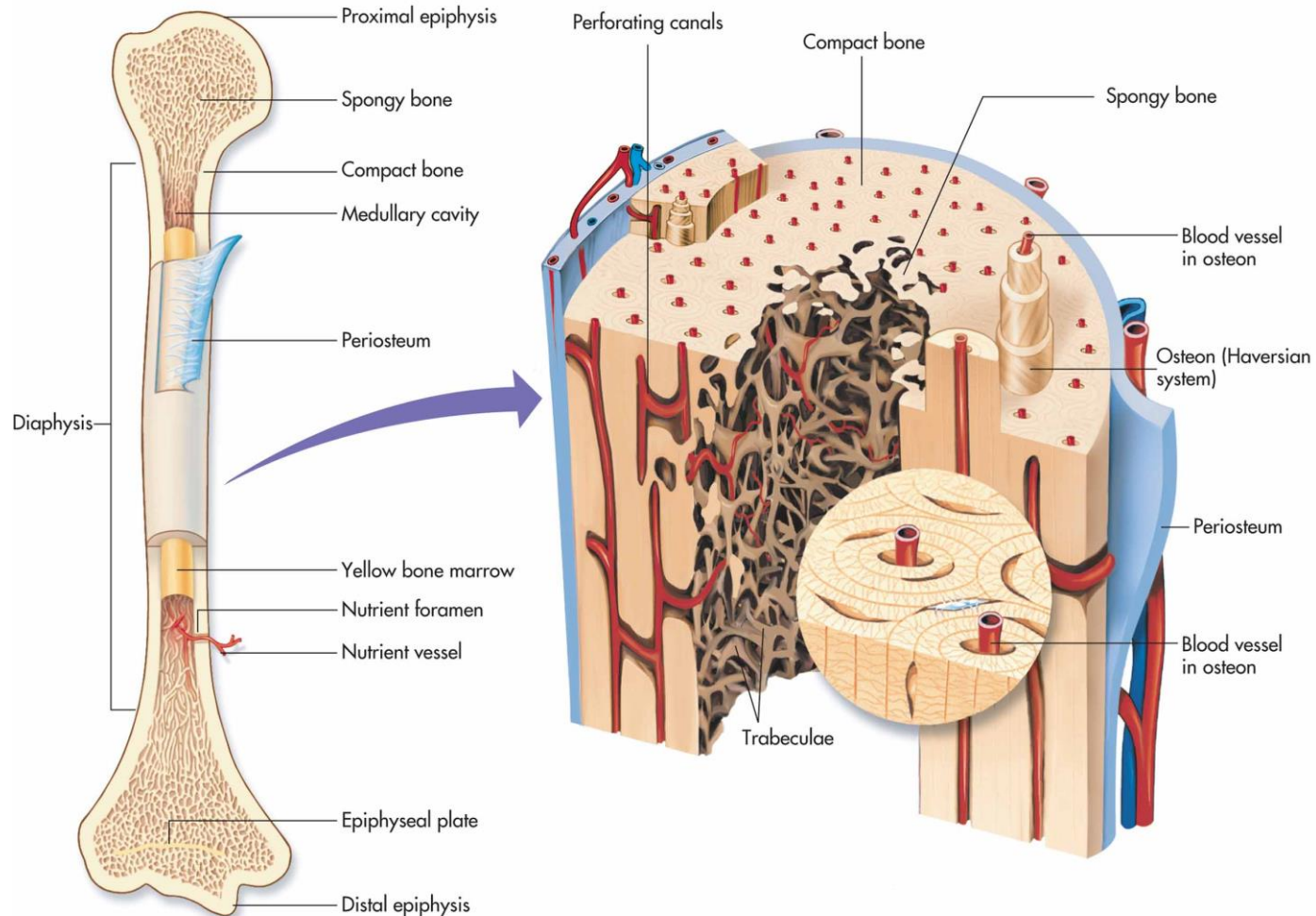


# Bone Tissue

1. **Compact bone** is **dense, hard tissue** normally composing the shafts of long bones and the outer layer of other bones.
  - Mature bone cells form concentric circles around blood vessels.
  - The area around the bone cells is filled with bone matrix.
2. **Spongy bone** is arranged in bars and plates (called trabeculae).
  - Irregular holes give the bone a spongy appearance and make the bone **lighter in weight**.



# Compact & Spongy Bone Tissue



# Surface Structure of Bones

- Bone is not perfectly smooth.
- Projections act as points of attachment for muscles, ligaments, or tendons.
- Grooves and depressions act as pathways for nerves and blood vessels.
- Projecting structures and depressions can work together as joining or articulation points to form joints such as the ball and socket joint in your hip.

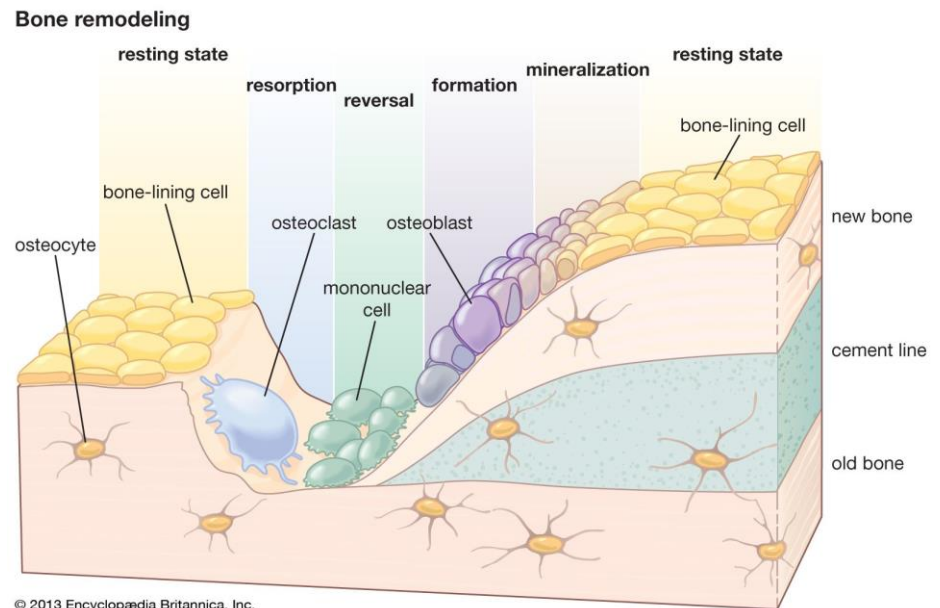


# Bone Growth & Repair

- **Ossification** is the formation of bone in the body.
  - Bone development begins when you are an embryo through ossification

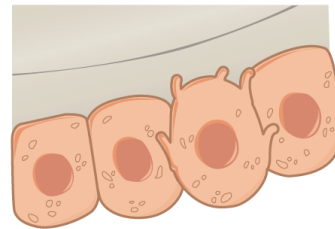
- Types of cells involved in bone formation and growth:

1. Osteoprogenitor cells
2. Osteoblasts
3. Osteocytes
4. Osteoclasts

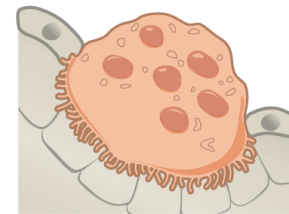


# Types of Cells

- Osteoblasts** are the cells that **actually form bones**.
  - These cells arise from non-specialized osteoprogenitor cells and are the cells that secrete the matrix of calcium with other minerals that give bone its typical characteristics.
- Osteoclasts** **tear down bone material** and help move calcium and phosphate into the blood.
  - It is believed that osteoclasts originate from a type of white blood cell called a monocyte that is found in red bone marrow.

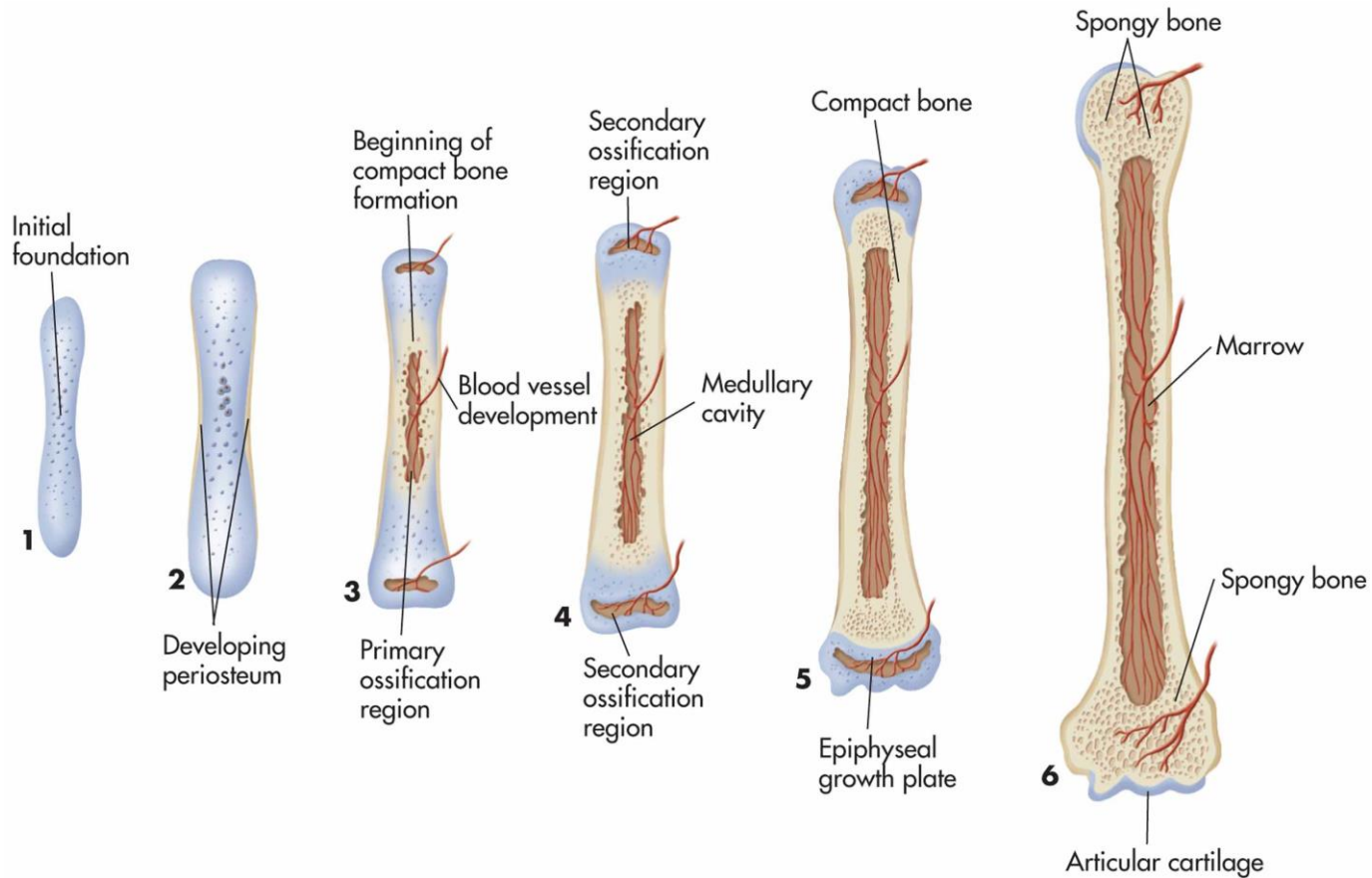


**Osteoblast**  
(forms bone matrix)



**Osteoclast**  
(resorbs bone)

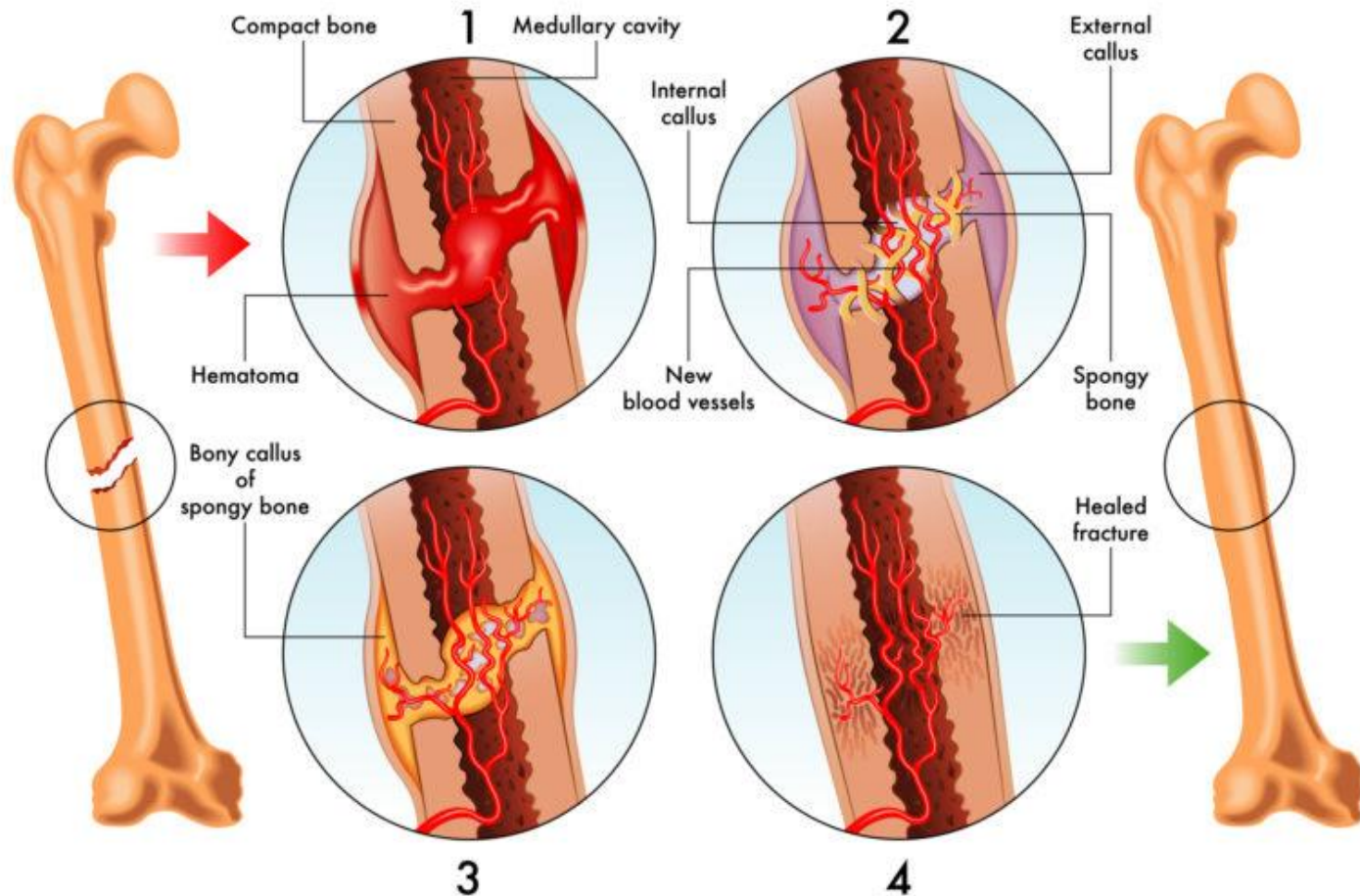
# Ossification of Long Bone



# Bone Repair

- For a bone fracture to heal, the ends of broken bone must be **touching**.
- **Four Stage Procedure** of bone repair:
  1. Hematoma forms; inflammation
  2. Soft callus forms (cartilage). Cartilage fills in the space between the bones.
  3. Bony callus forms. Bone replaces the cartilage.
  4. The bone is remodeled via the activity of osteoblasts and osteoclasts until the fracture is nearly undetectable.

# Bone Repair

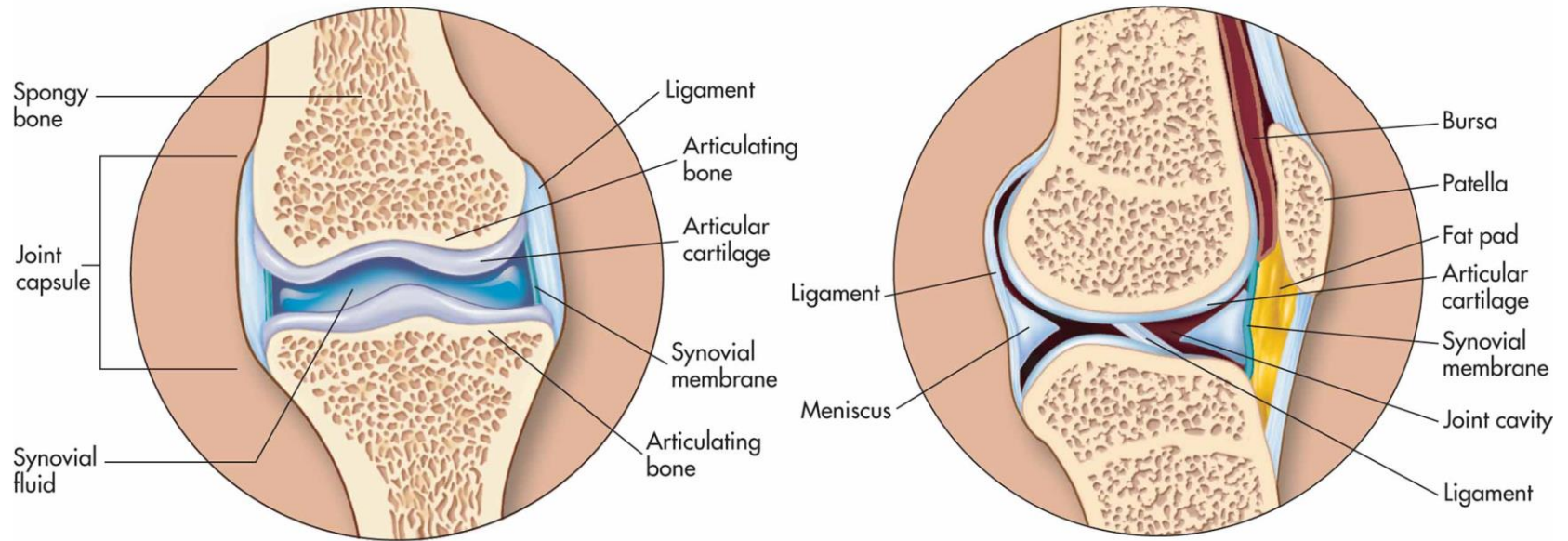


# Cartilage

- **Cartilage** cells are called chondrocytes. These cells exist in holes in a **gel-like matrix**.
- The flexible part of your nose and ears are cartilage.
- Makes a **flexible connection** between bones, as between the ribs and sternum, allowing chest flexion during deep breathing
- Cartilage acts as a **cushion between bones**; articular cartilage is located on the ends of bones and acts as a shock absorber, preventing the ends from grinding together during movement.



# Cartilage



# Joints & Ligaments

- **A Joint** (articulation) is formed when two or more bones join together
- **Ligaments** are special connective tissue that hold joints together, while still maintaining mobility. They are very tough, whitish bands that connect **bone to bone**.
- **Tendons** are cord-like structures that attach **muscle to bone**.

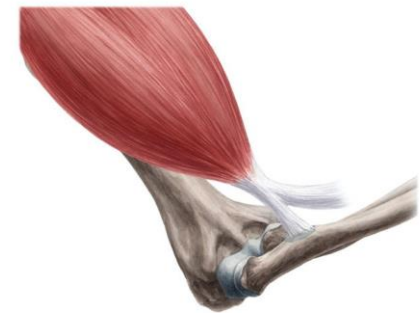
## Ligaments

Connects Bone with Bone



## Tendons

Connects Muscle with Bone



# Joints: Function & Structure

- A. Fibrous** are bones joined by short connective tissue strands. These joints are **immobile** (skull sutures).
- B. Cartilaginous** are bones united by cartilage and are able to **move a little** (pubic symphysis between pelvic bones).

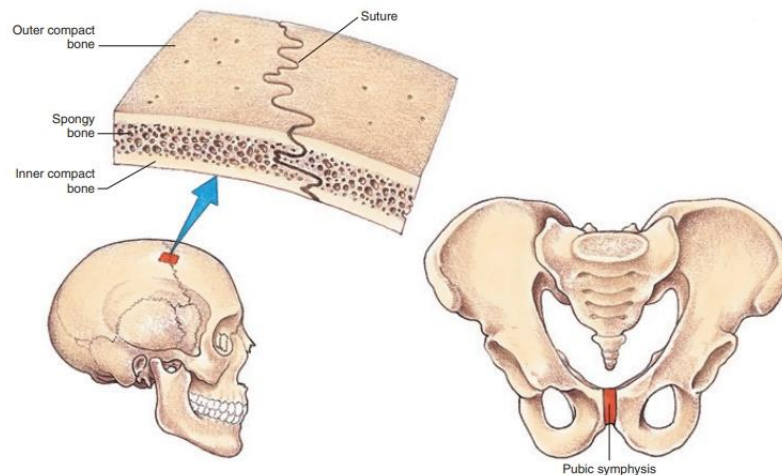


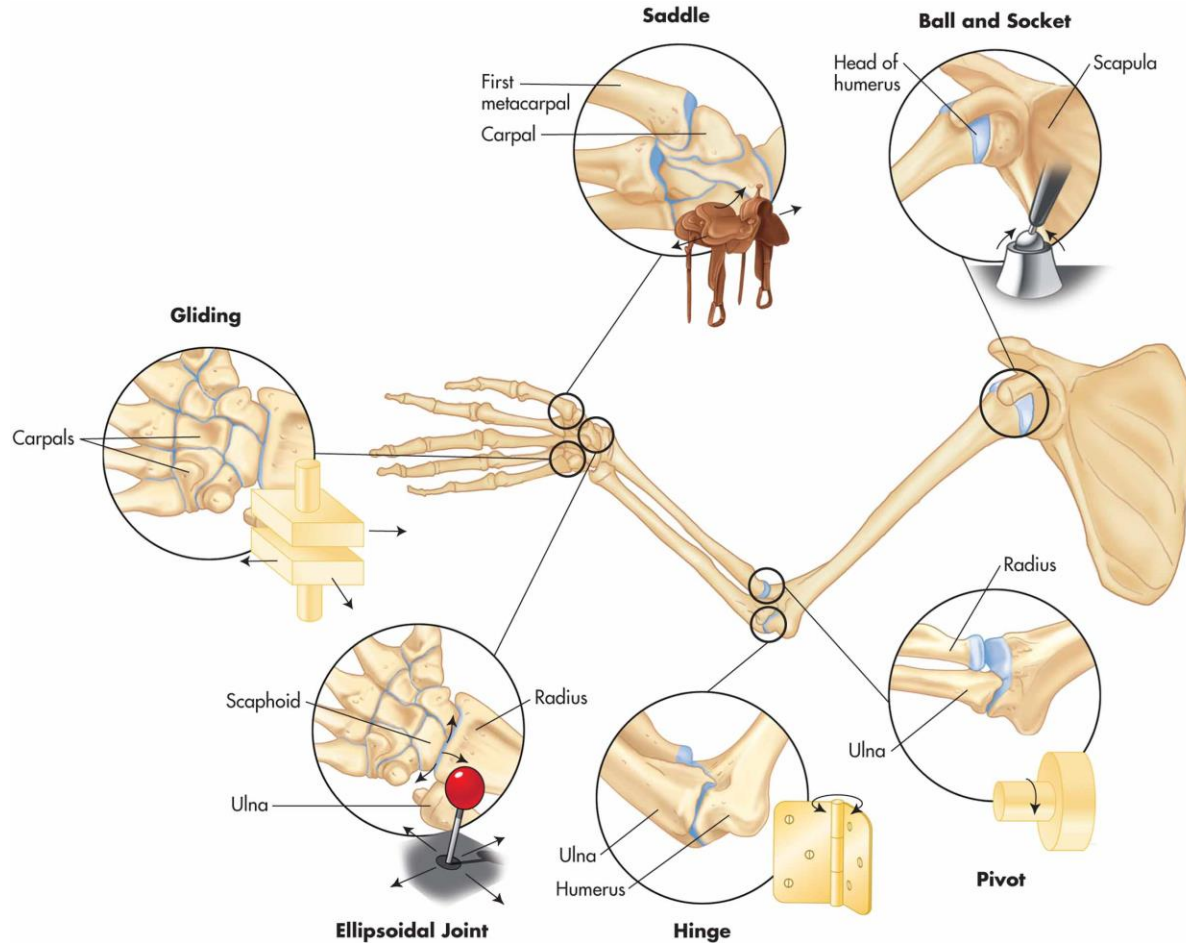
FIGURE 8-1 Examples of fibrous and cartilaginous joints.

# Joints: Function & Structure

**A. Synovial** are bones united by fluid filled joint cavity. These joints can **move freely** (elbow).

- Pivot joint – Turnstile movement in the neck and forearm
- Ball-and-socket joint – Hip and shoulder
- Hinge joint – Allow up and down movement in the knees and elbows
- Gliding joint – Wrists and ankles
- Saddle joint – Shaped like a saddle found in the thumb
- Ellipsoidal joint – Oval-shaped bone end fitting into an elliptical cavity in the other bone so there is movement from one plane to another but no rotation – fingers and toes

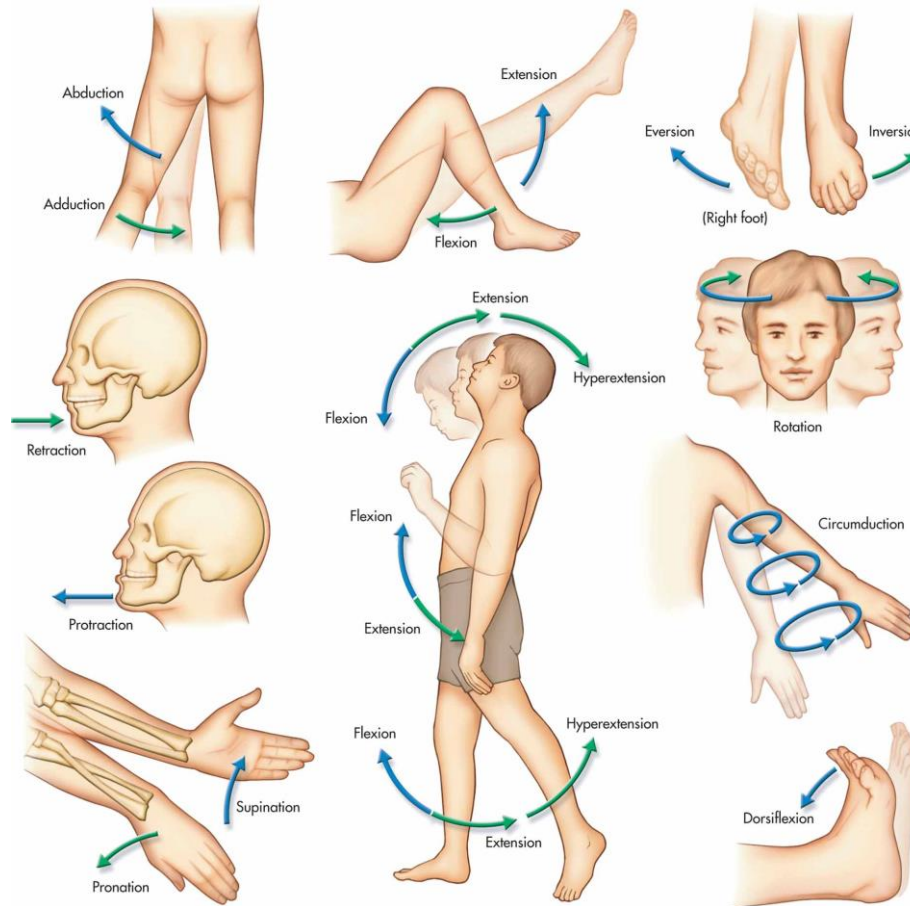
# Joints: Function & Structure



# Joint: Movement Classification

1. Flexion – decreasing the angle of a joint
2. Extension – increasing the angle of a joint
3. Plantar flexion – pointing toes down
4. Dorsiflexion – bending the foot up toward the body
5. Abduction – moving away from the body's midline
6. Adduction – moving toward the midline of the body
7. Inversion – turning the foot inward toward other foot
8. Eversion – turning the foot outward away from opposing foot
9. Circumduction – circular arm movement

# Joint: Movement Classification



# Bones of the Skeleton

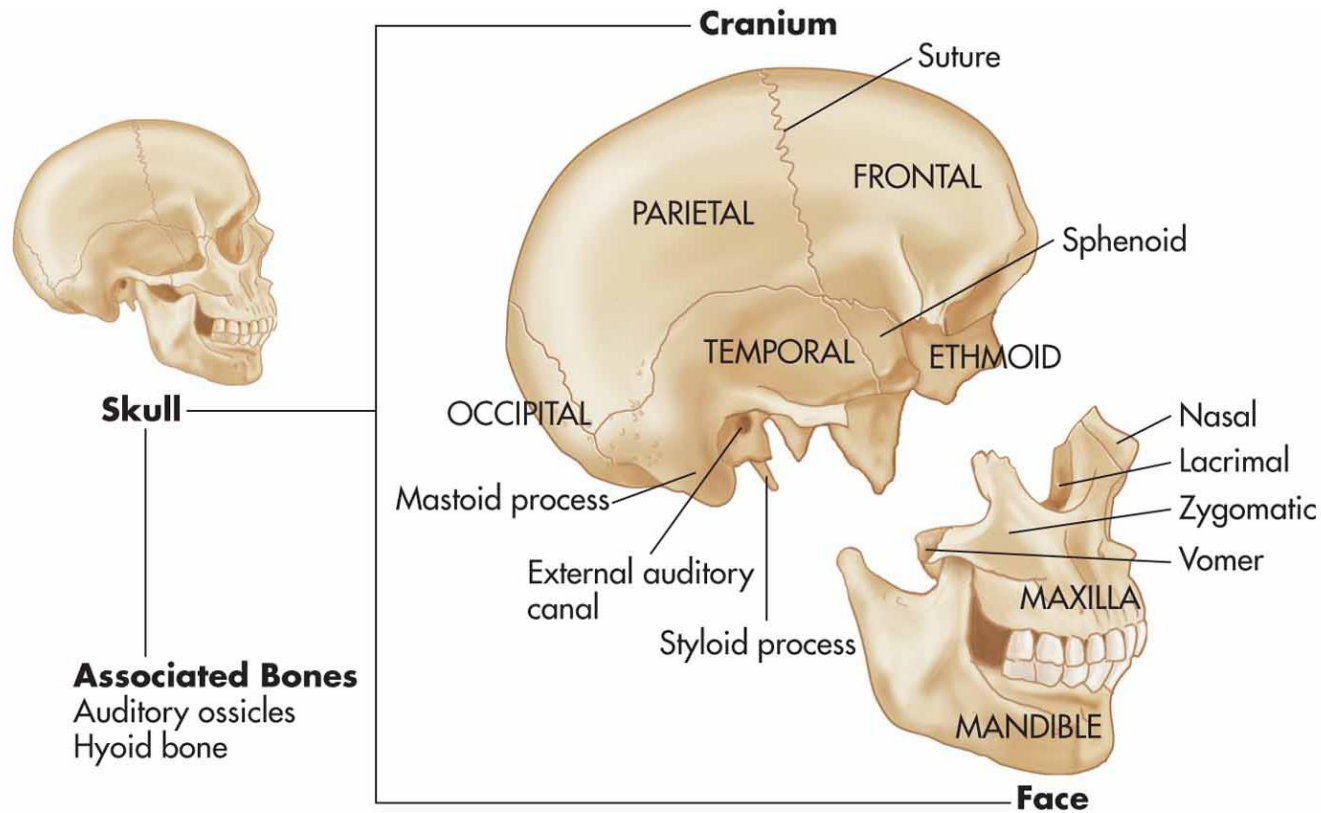
- There are two main sections of the skeleton

## 1. **Axial Skeleton** – 80 bones that protect the body organs

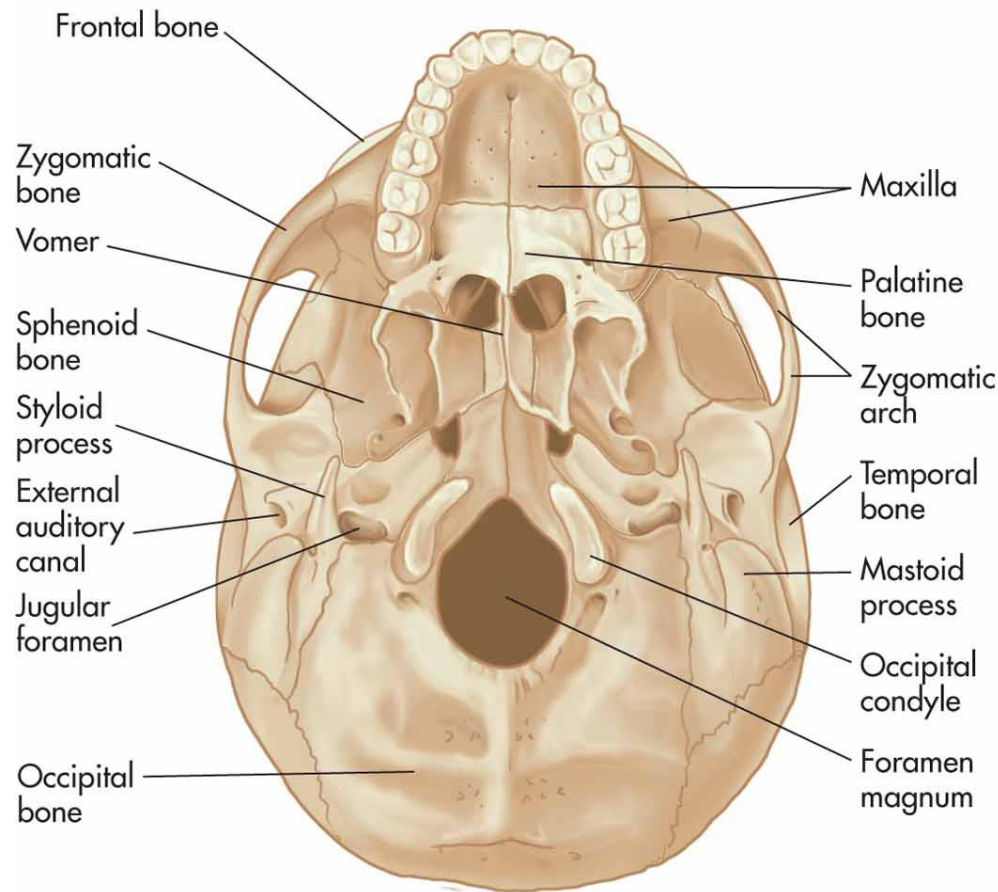
- **The Skull** – Many bones forming a brain case and facial structures
- **The Thorax** – Ribs and sternum (protects thoracic cavity)
- **The Spinal Column** - Also called vertebral column; houses the spinal cord; the superhighway for information coming to and from the central nervous system
  - The individual bones or vertebrae are numbered and classified according to the body region where they're located
- Also includes hyoid bone and bones of the middle ear



# Axial Skeleton: The Skull

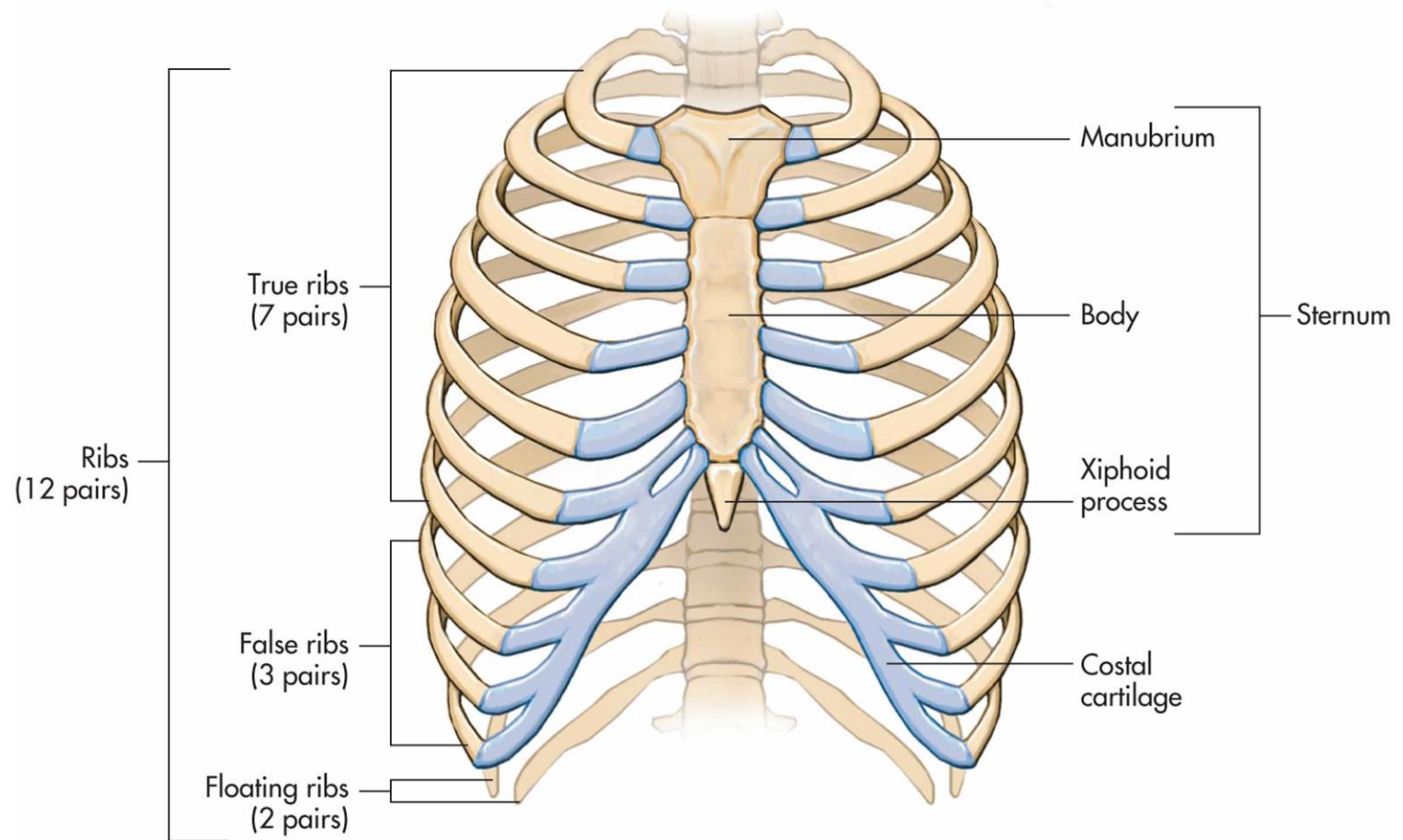


# Axial Skeleton: The Skull

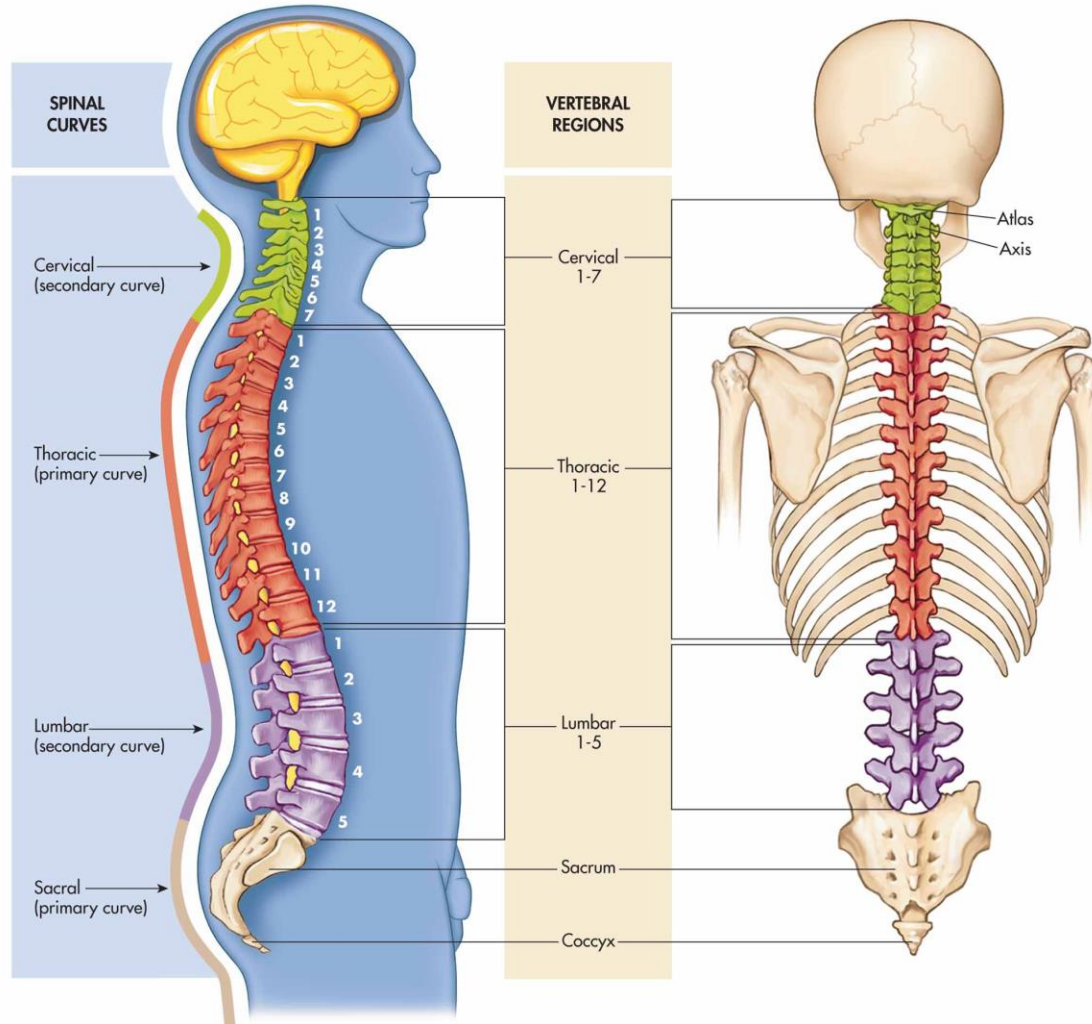


**Inferior view**

# Axial Skeleton: The Thorax



# Axial Skeleton: The Spinal Column



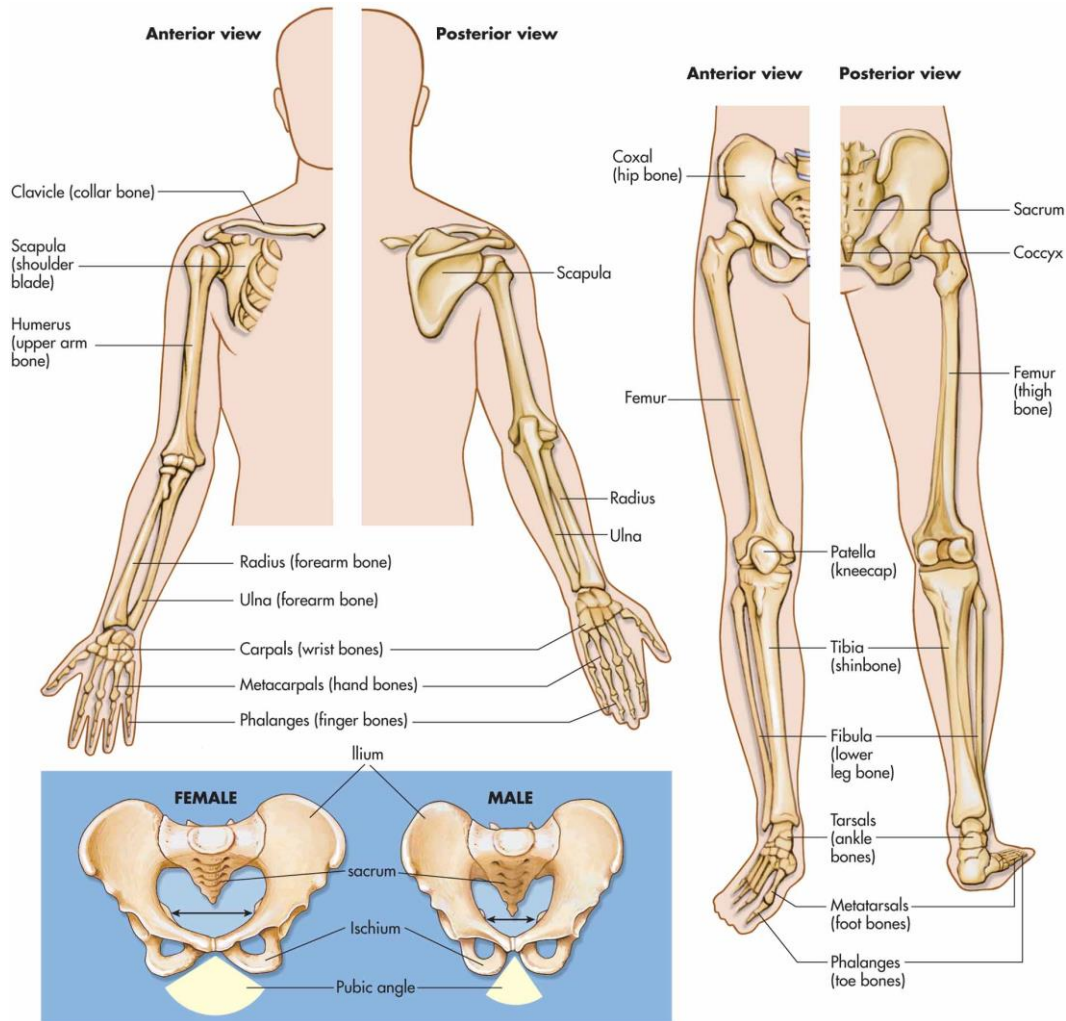
# Bones of the Skeleton

## 2. Appendicular Skeleton – 126 bones

- Arms
- Legs
- Hips
- Shoulders
- Half the bones in the body are located in the **hands and feet**



# Appendicular Skeleton



# Common Disorders: Arthritis

- **Aging** affects the cartilage and bones. While this is a natural process, in some cases we can slow things down. As we age, the **composition of cartilage changes**, becoming more brittle and yellow due to calcification, which can lead to arthritis.
- **Arthritis** is an **inflammatory** process of the joints that reduces flexibility and decreasing range of motion.
  1. **Osteoarthritis** is a degenerative condition and results of simple **“wearing out” of a joint** from a sports injury, trauma, repetitive motion, obesity, or just the aging process.
  2. **Rheumatoid arthritis** is an **autoimmune disease** that result of your body’s cells mistaking your own proteins as a foreign intruder.

# Common Disorders: Arthritis

Osteoarthritis



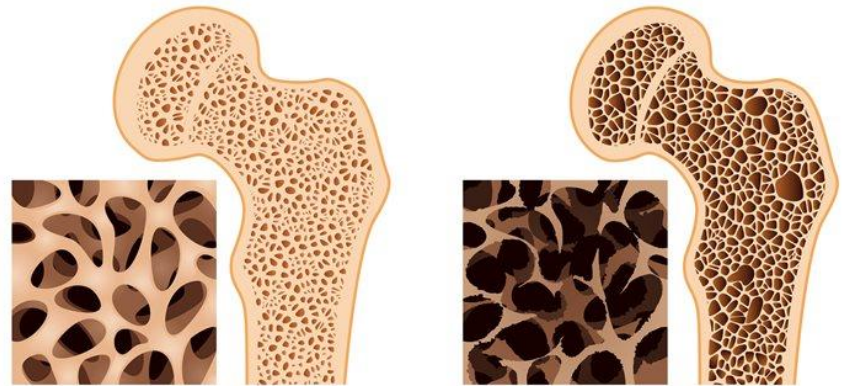
Rheumatoid





# Common Disorders: Osteoporosis

- Bone mass decreases with age. In our 50's the breakdown of bone is greater.
- **Osteoporosis**: light, weak, porous bones. It is more common in **women**, but can be diagnosed in men.
  - Treatment and prevention of osteoporosis:
    - Healthy lifestyle
    - Proper calcium intake
    - Proper vitamin D
    - Weight bearing exercise
    - Drink less caffeine
    - Quitting smoking
    - Medication (treatment)

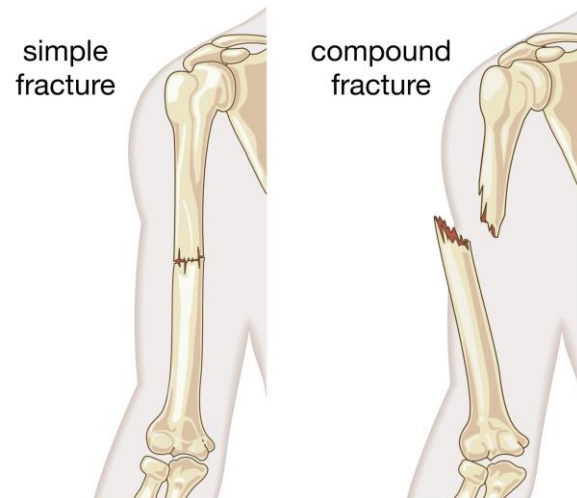


Healthy bone

Osteoporosis

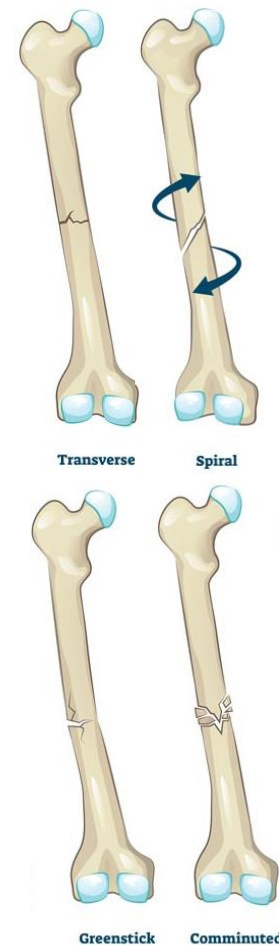
# Common Disorders: Bone Fractures

1. A **Simple or Closed Fracture** is a break with minimal displacement and **no tear in the skin**.
2. A **Compound or Open Fracture** occurs when the bone **protrudes through the skin**, with the potential of infection from exposure



# Common Disorders: Bone Fractures

3. A **Hairline Fracture** looks like a piece of hair on the x-ray. It is a fine fracture that doesn't completely break or displace the bone.
4. A **Spiral Fracture** is caused by a **twisting** motion to the bone.
5. A **Greenstick Fracture** is an incomplete break and is often found in children.
6. A **Comminuted Fracture** occurs when the bone fragments or **splinters**.



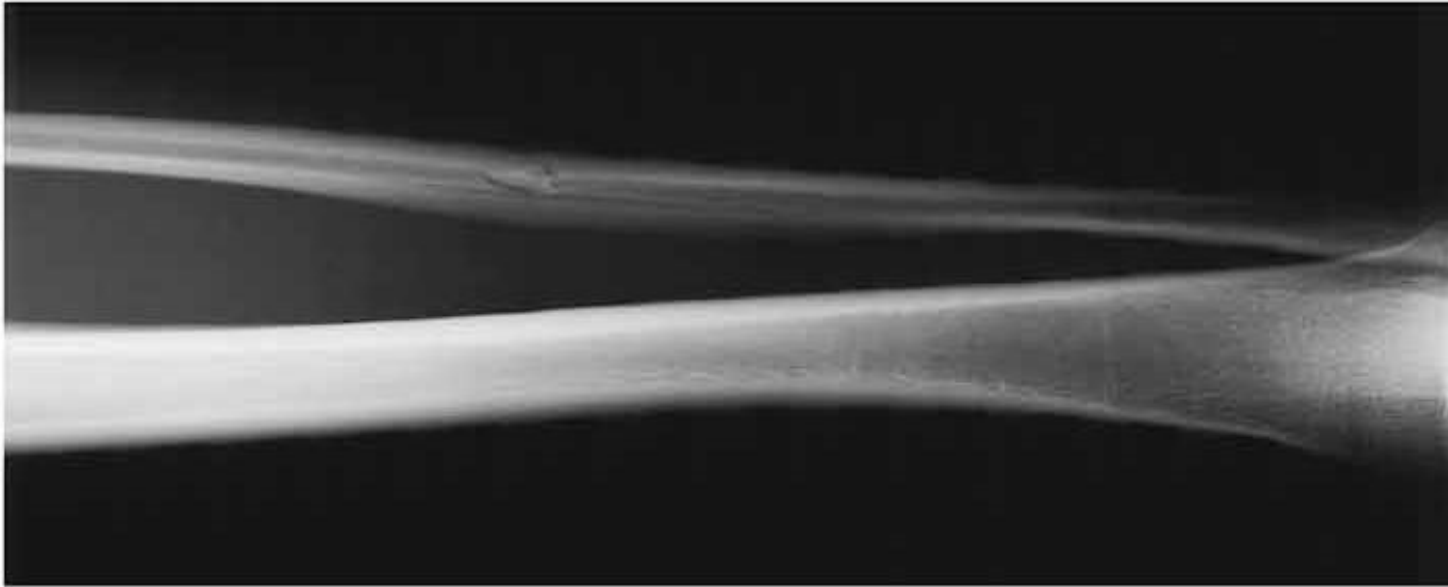
# Bone Fractures: Comminuted



**A**

**Figure 6-14** (A) Femur, AP view, comminuted fracture.

# Bone Fractures: Simple, Transverse



**B**

**Figure 6-14 (B)** Tibia, simple, transverse fracture.

# Bone Fractures: Complete,



**Figure 6-14 (E)** X-ray of complete fracture of the radius. (*Source: James Stevenson/Science Photo Library/Photo Researchers, Inc.*)

# Bone Fractures



**F**

**Figure 6-14 (F)** Fractured humerus. (*Source: Charles Stewart & Associates.*)

# Bone Fractures: Displaced



**Figure 6-14 (D)** Displaced fracture of the distal radius. (*Source: Charles Stewart & Associates.*)



# Bone Fractures: Open



**C**

**Figure 6-14 (C)** Open fracture of the wrist.