




# The Skeletal System



## I. Bone Structure

A. 206 bones in the human body.  
 B. An individual bone is composed of

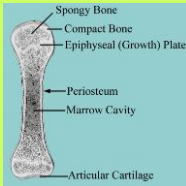
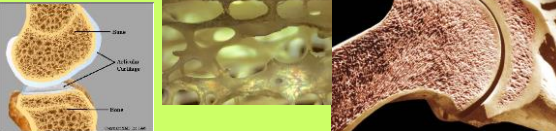
1. bone tissue (living and inorganic salts)
2. cartilage
3. fibrous connective tissue
4. blood
5. nerve tissue

## I. Bone Structure

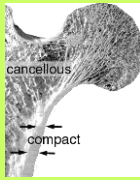
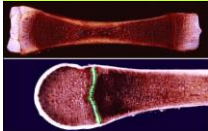

C. Parts of Long Bones

1. **Epiphyses**
  - a) Articulates with other bones.
  - b) Formed mostly by **spongy bone (cancellous)**.
    - 1) Many small bone plates
    - 2) Have irregular interconnected spaces.
    - 3) Keep bones light but very strong.
  - c) **Articular cartilage** covers the epiphyses.

## I. Bone Structure

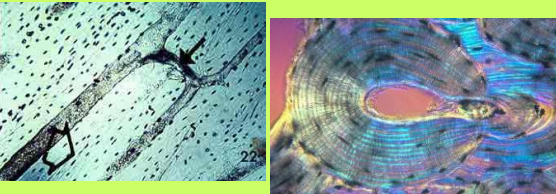
2. **Diaphysis (shaft)**
  - a) Wall is tightly packed compact bone.
  - b) **Medullary cavity** runs down the middle.
    - 1) Fades into the spongy bone.
    - 2) Filled with a soft connective tissue called marrow.
3. Bone is covered in a tough, vascular **periosteum**.
4. Periosteum fibers interlock with fibers of tendons and muscles.

## I. Bone Structure

D. Microscopic Structure

1. Osteocytes, lacunae, osteonic canals (Haversian), and lamellae form osteons (Haversian Systems)
2. **Perforating canals** (Volkmann's canals) connect osteonic canals.
3. Cells communicate by canaliculi.
4. Each osteonic canal houses one or two blood vessels and a nerve.
5. Nonliving matrix is collagen and calcium phosphate salts.



## II. Bone Development and Growth

A. Begins first few weeks of development.  
 B. Replaces existing connective tissue.  
 C. Two types of formation

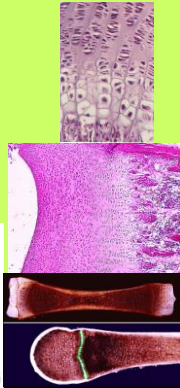
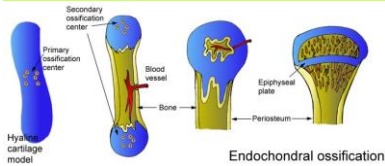
1. **Intramembranous Bone**
  - a) Bones of the skull are an example.
  - b) Membrane-like layers of connective tissue form osteoblasts.
  - c) Osteoblasts lay down matrix.
  - d) Membranous tissue on outside forms periosteum.




## II. Bone Development and Growth

### 2. Endochondral Bones

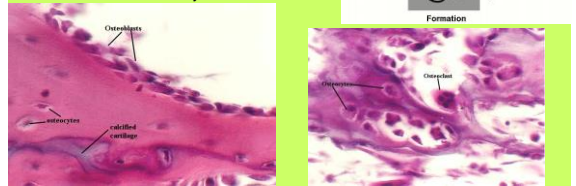
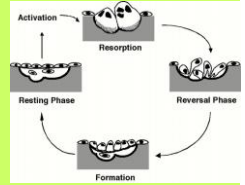
- Develop from masses of hyaline cartilage.
- Primary ossification center forms in diaphysis.
- Bone develops towards the ends.
- Secondary ossification centers form in the epiphyses.
  - Epiphyseal disks (cartilage) remain.
  - Epiphyseal disks are regions of long growth.



## II. Bone Development and Growth

### e) Compact Bone Cycle

- Multinucleated **osteoclasts** (fusion of white blood cells) form in center.
- Osteoclasts secrete acids and lysosomes to dissolve matrix.
- Osteoblasts lay down new bone.
- Bone is exchanged at a rate of 3-5% a year.



## III. Bone Functions (5)

- Support- lower limbs, pelvis, backbone.
- Protection- skull, rib cage, shoulder and pelvic girdle.
- Body Movement
  - Bones work with muscles to form a lever.
  - There are four parts to a lever.
    - rigid bar or rod
    - a pivot or fulcrum
    - object to be moved
    - force that supplies the energy.



## III. Bone Functions (5)

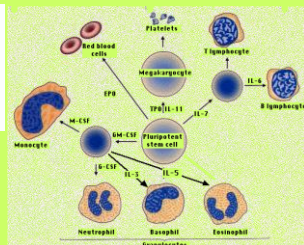
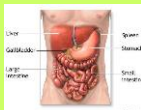
- The bending and straightening of the arm is an example of this simple machine.
  - the lower arm bones represent the rigid bar.
  - the elbow joint is the fulcrum.
  - the hand is the weight that is moved.
  - the force is supplied by muscles on the upper arm.



## III. Bone Functions (5)

### D. Blood Cell Formation (hematopoiesis)

- Begins in the yolk sac.
- Then in liver and spleen.
- Finally in bone marrow



## III. Bone Functions (5)

### 4. Red Marrow

- Forms erythrocytes (red), leukocytes (white), and thrombocytes (platelets)
- Red due to pigment hemoglobin.
- Fills most bone cavities as an infant.
- Mainly in spongy bone of skull, ribs, sternum, clavicles, vertebrae, and pelvis in adults.



### 5. Yellow Marrow

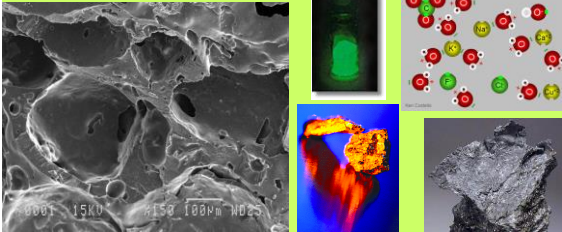
- Replaces red marrow in most bones.
- Stores fat.



### III. Bone Functions (5)

#### E. Storage of Inorganic Salts

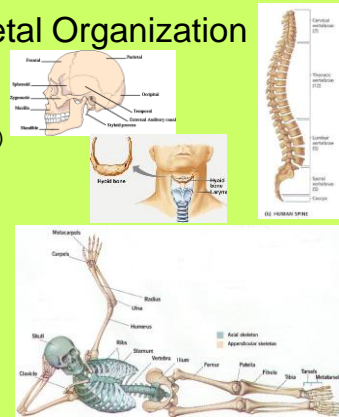
1. Calcium and phosphate- released by osteoclasts, stored by osteoblasts.
2. Ions: Magnesium, sodium, potassium, and carbonate.
3. Harmful metals such as lead, mercury, radium, and strontium.



### IV. Skeletal Organization

#### A. Axial Skeleton

1. Skull(22)
  - a) **cranium**(8)
  - b) **facial bones**(13)
  - c) **mandible**(1)
2. Middle Ear Bones(6)
3. **Hyoid**(1)- supports tongue, attachment for muscles.
4. Vertebral Column(26)
  - a) **cervical**(7)
  - b) **thoracic**(12)
  - c) **lumbar**(5)
  - d) **sacrum**(1)
  - e) **coccyx**(1)



### IV. Skeletal Organization

#### 5. Thoracic Cage(25)

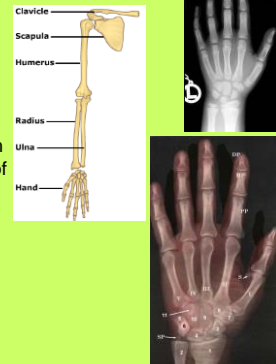
- a) **Ribs**(24)
  - 1) seven true ribs (vertebrosternal)
  - 2) five false ribs
    - i. three vertebrochondral ribs
    - ii. two floating ribs (sometimes three)
- b) **Sternum**(1)- three sections
  - 1) manubrium
  - 2) middle body
  - 3) xiphoid process



### IV. Skeletal Organization

#### B. Appendicular Skeleton

1. Pectoral Girdle(4)
  - a) **scapula**(2)- shoulderblade
  - b) **clavicle**(2)- collarbone
2. Upper Limbs(60)
  - a) **humerus**(2)- upper arm
  - b) **radius**(2)- thumb side of forearm
  - c) **ulna**(2)- longer than radius
  - d) **carpals**(16)- form carpus(wrist)
  - e) **metacarpals**(10)- palm to knuckles
  - f) **phalanges**(28)- fingers and thumb



### IV. Skeletal Organization

#### 3. Pelvic Girdle

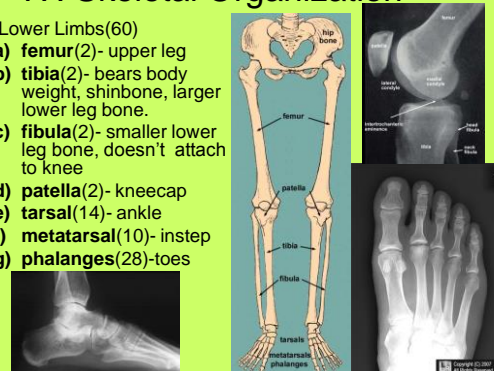
- a) **coxal bones**(2)- fusion of three bones
  - 1) ilium- prominences of hip
  - 2) ischium- lowest portion
  - 3) pubis- where coxal bones join
- b) together with sacrum and coccyx forms pelvis



### IV. Skeletal Organization

#### 4. Lower Limbs(60)

- a) **femur**(2)- upper leg
- b) **tibia**(2)- bears body weight, shinbone, larger lower leg bone.
- c) **fibula**(2)- smaller lower leg bone, doesn't attach to knee
- d) **patella**(2)- kneecap
- e) **tarsal**(14)- ankle
- f) **metatarsal**(10)- instep
- g) **phalanges**(28)-toes



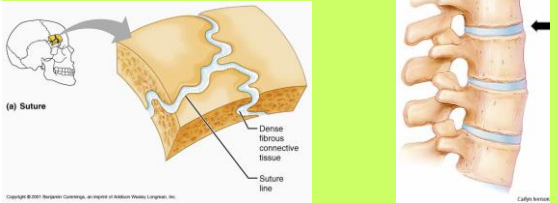
## V. Joints (articulations)

### A. Fibrous Joints

1. Thin layer of fibrous connective tissue.
2. Between bones in close contact.
3. No real movement between bones (sutures in skull)

### B. Cartilaginous Joints

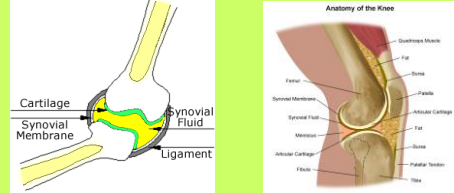
1. Fibrocartilage or hyaline cartilage between bones.
2. Limited movement (intervertebral disk)



## V. Joints (articulations)

### C. Synovial Joints

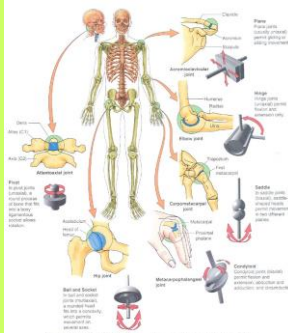
1. Most joints are synovial (free moving)
2. Synovial membrane lines cavity and secretes synovial fluid.
3. May have pads of fibrocartilage (menisci)
4. May have fluid filled sacs called bursae between skin and bony prominences(knee,shoulder)



## V. Joints (articulations)

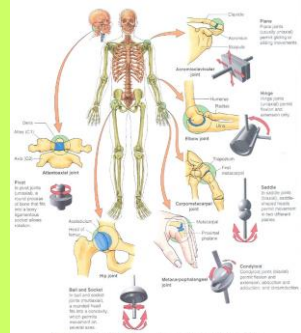
### D. Classification of Joints (based on movement)

1. **Ball-and-socket:** movement in all planes + rotational (shoulder, hip)
2. **Condylloid:** oval surface into an elliptical cavity, movement in many planes, no rotation (phalanges)
3. **Gliding:** flat or curved surfaces, sliding and twisting (vertebrae)



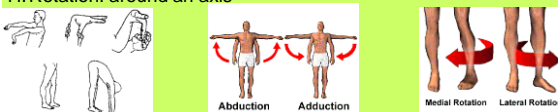
## V. Joints (articulations)

4. **Hinge:** convex surface into concave cavity, movement in one plane only (elbow)
5. **Pivot:** cylindrical surface rotates in ring of bone and tissue, rotation around axis only (radius and ulna)
6. **Saddle:** surface is concave and convex and complements cavity, movement in a variety of planes (thumb)



## VI. Types of Movement

- A. Flexion: decreasing angle, when the knee bends
- B. Extension: increasing angle, when the knee extends
- C. Dorsiflexion: the foot bending upwards at the ankle
- D. Plantar flexion: The foot extending downward
- E. Hyperextension: excessive extension
- F. Abduction: away from the midline
- G. Adduction: toward the midline.
- H. Rotation: around an axis



## VI. Types of Movement

- I. Circumduction: in a circular motion
- J. Pronation: turning the palm so the hand is downward
- K. Supination: turning the palm so the hand is upward
- L. Eversion: turning the foot so the sole is outward
- M. Inversion: turning the foot so the sole is inward
- N. Retraction: moving part backward
- O. Protraction: moving part forward
- P. Elevation: raising a body part
- Q. Depression: lowering a body part

