

## LOCOMOTION AND MOVEMENT

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- Human endoskeleton is made up of 206 bones. It is grouped into two parts –

→ Appendicular skeleton – 126 bones.

→ Axial Skeleton – 80 bones.

### Axial Skeleton

- It consists of skull, vertebral column, sternum and ribs.
  - Skull is composed of cranial and facial bones. Total – 22 bones
  - Cranial bones are 8 in number. Frontal(1), parietal(2), occipital(1), temporal(2), sphenoid(1), ethmoid(1).
  - Facial bones are 14 in number. Mandible(1), maxilla(2), palatine(2), nasal(2), vomer(1), inferior turbinals(2), zygomatic(2), lacrimal bones(2).
- Each middle ear contains three tiny bones malleus, incus and stapes, collectively called ear ossicles.
- **Hyoid bone:**– A single U-shaped bone which is present at the base of the buccal cavity.
- **Vertebral column:**– Formed by 26 serially arranged vertebrae. Cervical (7) Thoracic (12) Lumbar (5) Sacral (1 fused), coccygeal (1 fused)
- The number of cervical vertebrae are seven in almost all mammals including human beings.
- First vertebra is the atlas and it articulates with the occipital condyles of skull.

→ **Sternum:**– A flat bone on the midventral line of thorax.

Ribs – 12 pairs

– 1st 7 pairs – True ribs (vertebro-sternal ribs)

– 8, 9, 10th pairs – vertebro-chondral ribs.

– 11, 12th pairs – vertebral ribs (floating ribs)

- Each rib is a thin flat bone. It has two articulation surfaces on its dorsal end and is hence called bicephalic.
- Thoracic vertebrae, ribs and sternum together form the rib cage.

### Appendicular Skeleton

- The bones of limbs along with their girdles.
  - **Fore Limb** – 30 bones. Humerus, radius, ulna, carpals (wrist bones-8) metacarpals (palm-5) phalanges (digits-14)
  - **Hind Limb** – 30 bones. Femur, Patella, Tibia, Fibula, Tarsals (Ankle-7), metatarsals (sole-5), Phalanges (digits-14)
- Femur is the longest bone of body.

**Pectoral girdle** – Each half is made up of a clavical (collar bone) and a scapula bones.

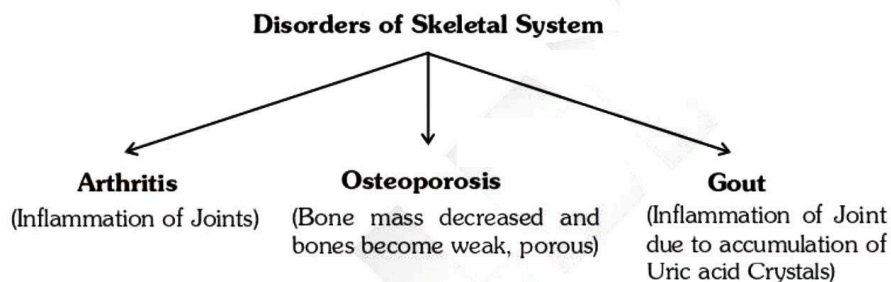
- Glenoid cavity is a depression in the scapula bone in which the head of the humerus bone articulates and forms the shoulder joint.

**Pelvic girdle** – It consists of two coxal bones.

- Each coxal bone is formed by fusion of ilium, ischium and pubis. At the point of fusion of the above bones acetabulum cavity is present in which head of femur articulates. The two halves of the pelvic girdle meet ventrally to form the pubic symphysis containing white fibrous cartilage.

## JOINTS

1. **Fibrous joint** – Do not allow any movement e.g.: Sutures (between skull bones)
2. **Cartilaginous Joint** – The bones involved are joined together with the help of cartilage e.g.: Intervertebral disc, pubic symphysis.
3. **Synovial joint** – Characterised by the presence of a fluid filled synovial cavity between the articulating surface of two bones. e.g.: Ball and Socket, Hinge, Pivot, Gliding, Saddle joints.
  - Ball and socket joint (between Humerus and Pectorial girdle)
  - Hinge Joint (Knee Joint, Elbow Joint)
  - Pivot Joint (between atlas and axis)
  - Gliding Joint (between the carpals, between the adjacent vertebrae).
  - Saddle Joint (between carpal and metacarpal of thumb)



## HUMAN SKELETON - 206 BONES

### APPENDICULAR SKELETON - 126 BONES

#### LIMB BONES - 120

##### FORELIMB BONES - 60

HUMERUS - 1X2  
 RADIUS - 1X2  
 ULNA - 1X2  
 CARPALS - 8X2  
 METACARPALS - 5X2  
 PHALANGES - 14X2

##### HINDLIMB BONES - 60

FEMUR - 1X2  
 PATELLA - 1X2  
 TIBIA - 1X2  
 FIBULA - 1X2  
 TARSALS - 7X2  
 METATARSALS - 5X2  
 PHALANGES - 14X2

#### GIRDLE BONES - 06

##### PECTORAL GIRDLE - 4

SCAPULA - 1X2  
 CLAVICLE - 1X2  
 PELVIC GIRDLE - 2

### AXIAL SKELETON - 80 BONES

##### SKULL SKELETON- 29

##### SKULL BONES - 22

##### STERNUM - 01

##### RIBS - 24

##### TRUE - 14

##### VERTEBRAL COLUMN - 26

##### CERVICAL - 7

<b>CRANIAL - 8</b>	<b>FACIAL - 14</b>	<b>FALSE - 10</b>	<b>THORACIC - 12</b>
FRONTAL - 1	MAXILLA - 2		LUMBAR - 5
PARIETAL - 2	PALATINE - 2		SACRAL - (5)
TEMPORAL - 2	MALAR - 2		COCCYGEAL - (4)
OCCIPITAL - 1	NASAL - 2		
ETHMOID - 1	LACRYMAL - 2		
SPHENOID - 1	INFERIOR TURBINALS - 2		
	MANDIBLE - 1		
	VOMER - 1		

#### **ASSOCIATED SKULL BONES - 07**

HYOID BONE - 1

EAR OSSICLES - 2X3 (MALLEUS , INCUS , STAPES)

**Phalangeal formula is 23333**

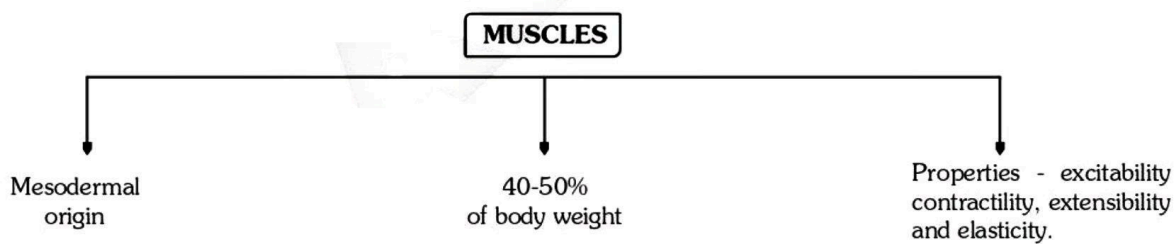
**Bones formed by ossification of tendons are called sesamoid bones.**

**Longest and strongest bone of human body is femur.**

**Smallest bone of human body is stapes.**

**Rabbit - axial skeleton 132 bones , appendicular skeleton 128 bones**

### **MUSCLES**



**Types of muscles : -**

<b>SKELETAL MUSCLES</b>	<b>VISCERAL MUSCLES</b>	<b>CARDIAC MUSCLES</b>
→ Striped muscles	→ Unstriped Muscles	→ Striated muscles
→ Voluntary muscles	→ Involuntary muscles	→ Involuntary muscles
→ These muscles are primarily involved in locomotory actions and change in body postures.	→ Located in wall of hollow organs.	→ Found in Heart

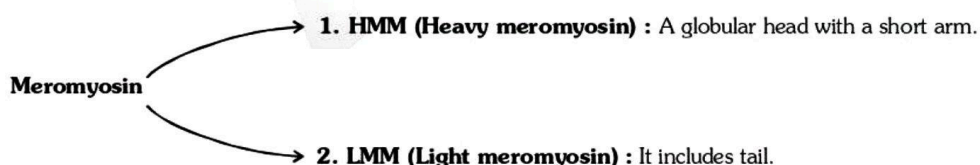
- Skeletal muscle is made of muscle bundles or fascicles. Fascicles held together by fascia.
- Each muscle bundle made up of many muscle fibres.
- Skeletal muscle fibre is long, unbranched, multinucleated (syncytium).
- Skeletal muscle fibre contains sarcoplasmic reticulum which is store house of calcium ions.
- Many parallelly arranged filaments are present in sarcoplasm called myofilaments or myofibrils.
- Each myofibril has alternate dark and light band on it.
- Light band or I-band or isotropic band contains actin proteins where dark band or A-band or anisotropic band contains myosin proteins.
- Z-Line (elastic fibre) is found in the centre of each T band.
- M Line (thin fibrous membrane) is found in middle of A-band.

"The portion of the myofibril between two successive 'Z'-Lines is considered as the functional unit of contraction is called Sarcomere."

- In resting stage, the edges of thin filaments partially overlap the free ends of the thick filaments leaving the central part of the thick filaments.
- This central part of thick filament, not overlapped by thin filaments is called the 'H' Zone.

#### **Structure of Contractile Proteins :-**

- Each actin is made of two 'f' (filaments) actins which are helically coiled to each other.
- 'f' actin is polymer of 'G' (Globular) actins.
- Two filaments of tropomyosin protein also run close to 'f' actins throughout its length.
- A complex protein troponin is distributed at regular intervals on the tropomyosin.
- In the resting state troponin masks the active binding sites for myosin on the actin filaments.
- Each myosin filament is a polymerized protein. Many meromyosin (monomeric protein) found in one thick filament.



**NOTE:** ATPase enzyme and binding site for ATP and actin present on globular head.

#### **Mechanism of muscle contraction :-**

- It is best explained by sliding filaments theory.
- During this, thin filaments slide over the thick filaments.
- Muscle contraction is initiated by a signal sent by the central nervous system.
- A neural signal reacting at neuromuscular junction or motor end plate (junction between motor neuron and sarcolemma) releases a neuro-transmitter (Acetylcholine) which generates an action potential in sarcolemma.



- Action potential spreads through the sarcolemma and causes release of  $\text{Ca}^{+2}$  into sarcoplasm.
- When  $\text{Ca}^{+2}$  level increase it leads to binding of  $\text{Ca}^{+2}$  with subunit of troponin on actin filament remove masking of active sites on actin to form a cross-bridge. (Energy obtained from ATP hydrolysis).
- Actin filaments move towards centre of A-band.
- Length of sarcomere decreases.
- I-band get reduced where as 'A' band retain the length.
- The myosin releasing ADP and P goes back to its relaxed stage.

#### **Muscle Fatigue : -**

- Repeated activation of muscle can lead to accumulation of lactic acid due to anaerobic breakdown of glycogen causing fatigue.

#### **Types of muscles fibres : -**

Red Muscle Fibre	White Muscle Fibre
<ul style="list-style-type: none"> <li>• Myoglobin content is high (myoglobin is red coloured oxygen storing pigment).</li> <li>• More number of mitochondria present.</li> <li>• Aerobic muscle fibres.</li> <li>• Amount of sarcoplasmic reticulum is low.</li> </ul>	<ul style="list-style-type: none"> <li>• Myoglobin content is Low.</li> <li>• Less number of mitochondria present.</li> <li>• Anaerobic muscle fibres.</li> <li>• Amount of sarcoplasmic reticulum is high.</li> </ul>