

Locomotion and Movement

- All locomotion is kind of movement.
- These movement result in change of place or body posture, such movement called locomotion.
- All locomotion are movement but all movement are not locomotion.
- Locomotion is a character of animal.
Movement is a character of Plant.
- Locomotion is due to co-ordination b/w skeleton system, muscular system and Nervous system.

Eg: Amoeba → Protoplasmic streaming

↓
develop pseudopodia (false feet)
↓
help in locomotion

Paramecium → have cilia
(Cause Car like movement)

↓
help in locomotion movement of food through cytopharynx.

Hydra → have tentacles

- ↳ help in locomotion
- ↳ capturing of prey

→ Human body cell exhibit different types movement.

① Amoeboid movement

shown by

- ↳ macrophages cells or phagocytic cell.
- ↳ leucocyte cell or WBCs.

Eg:- Monocyte and neutrophils are phagocytic cells they may be move in opposite dirn of blood with the help of amoeboid (pseudopodia).

NOTE:

Cytoskeleton or microfilaments of cell also show amoeboid movement.

II) Ciliary Movement

shown by → Trachea (wind pipe) cause the movement mucus.

→ Muscle → Fallopian tube (oviduct) cause the movement of ova in genital tract.

→ muscular mov. shown by muscle

→ 40 to 50% body weight contribute by muscle

→ Property muscle → excitability, contractility, extensibility, elasticity.

III) Muscular movement

On the basis of location mainly, structure & function, muscles are of three types:-

- i) skeleton muscle
- ii) smooth muscle
- iii) Cardiac muscle

* Skeleton Muscle

- closely associated with skeletal system
- striated
- voluntary
- multinucleate
- help in locomotion, writing and facial expression

* Smooth Muscle

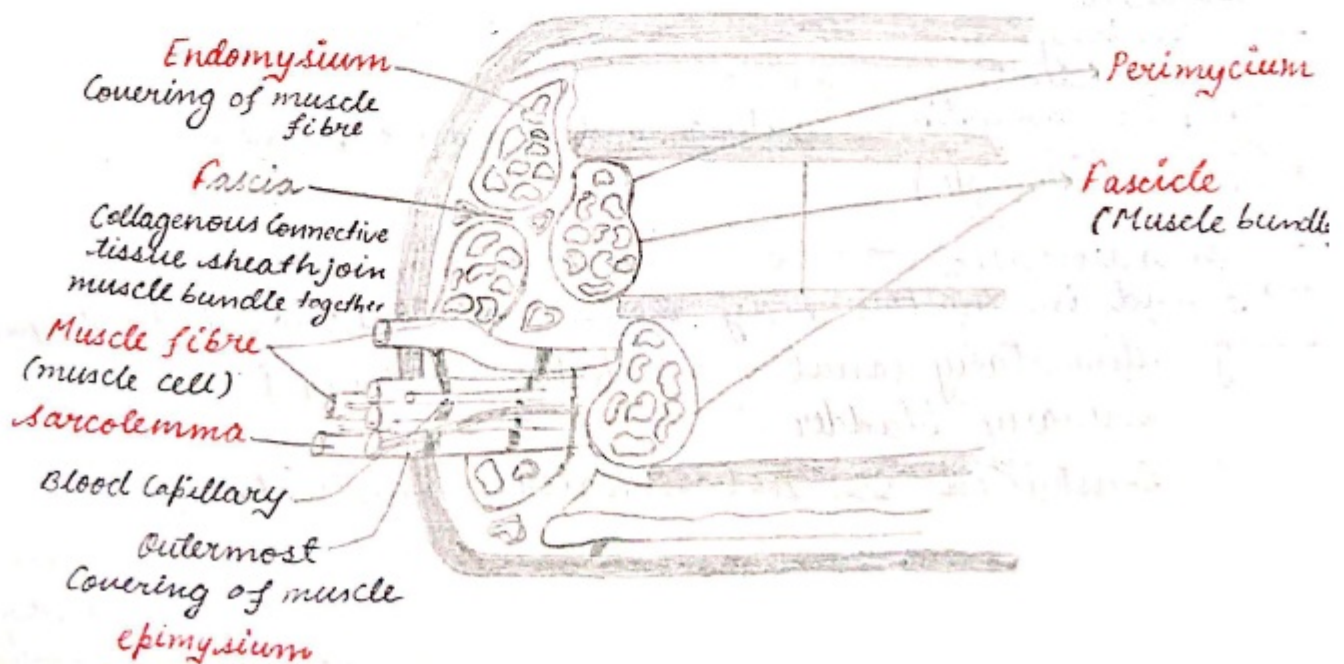
- uninucleated
- found in hollow body organ or internal body organ.
- eg; alimentary canal → intestine, stomach etc.
urinary bladder

Constricted or not striated; involuntary

do not under conscious mind

Cardiac muscle

- found in heart wall (myocardium)
- striated (just like skeletal muscle)
- Involuntary (just like smooth muscle)
- Usually uninucleated (one nucleus in cell)
- all are branched & interconnected (having bridge)
- Contractions are rhythmic and automatic (myogenic heart - current originate from muscle).
- Intercalated disc are present in some places or location (join the cells for synchronized contraction).
- Do not get fatigued easily.



Skeletal muscle

Muscle bundles / fascicles

↓
Muscle Bundles are interconnected by collagenous connective tissue sheath - fascia

Muscle fibres / muscle cells

↓
Myofibrils / myofilaments

Light band

- contain Actin
- called I-band
- Isotropic band
- Thin filaments

2F-actins

↓
G1-actins

or
Globular

2-tropomyosin

(Having tropoinin)

Dark band

- contain Myosin
- called A-band
- Anisotropic band
- Thick filament

Meromyosin

HMM

heavy Meromyosins

Head

Actin binding sites

ATP binding sites

have ATPase enzymes

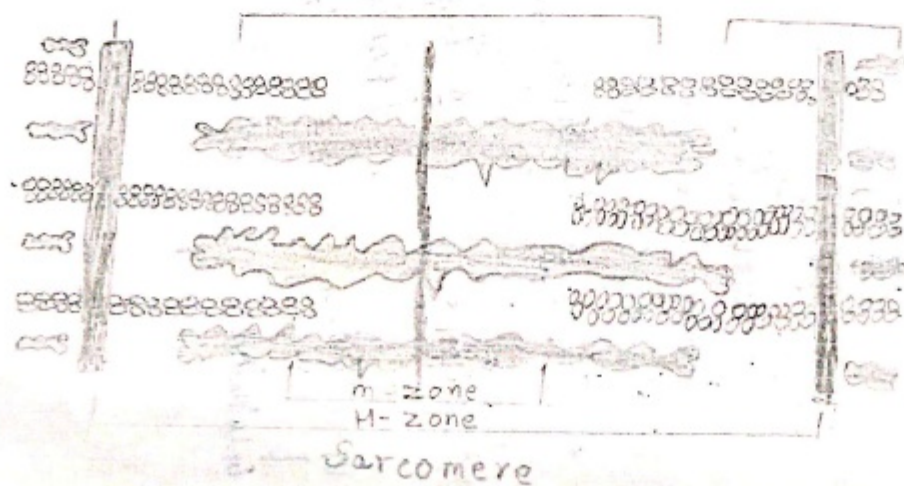
LMM

light Meromyosin

Tail

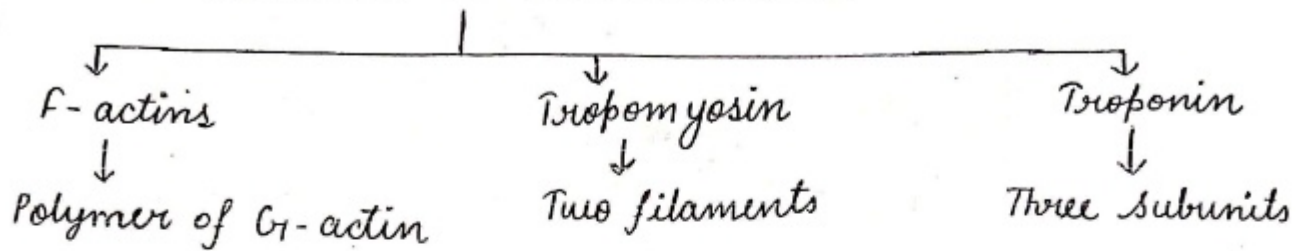
→ Structure of Skeletal Muscle

- Muscle fibres are found in each muscle bundle.
- Plasma membrane called sarcolemma
- Sarcolemma encloses the sarcoplasm.
- Sarcoplasm contains many nuclei, called a syncytium
- Nucleus present peripheral space b/w sarcolemma & myofibrils.
- Endoplasmic reticulum (sarcoplasmic reticulum) of muscle fibres is storehouse of calcium ions.
- muscle fibres parallelly arranged filaments is the sarcoplasm called the myofilament or myofibrils.
- Each myofibrils has alternate dark and light bands on it.
- Myofibril has striated form is due to the distribution of two main proteins → Actin & Myosin.
- Actin and Myosin are arranged as rod like structures.
- In the middle of each I-band, it has an elastic fibres dividing it called Z-line.
- Thin fibres are strongly (firmly) connected to the Z-line.
- Thick filament of 'A' band are joined by thin fibrous membrane in the middle of the band called M-line.
- 'A' and 'I' bands are arranged in alternate.
- The part of the myofibril located b/w the two successive 'Z' lines are considered as a functional unit of muscle contraction called sarcomere.
- The central part of thick filament which does not overlap with thin filaments, is called 'H'-Zone.



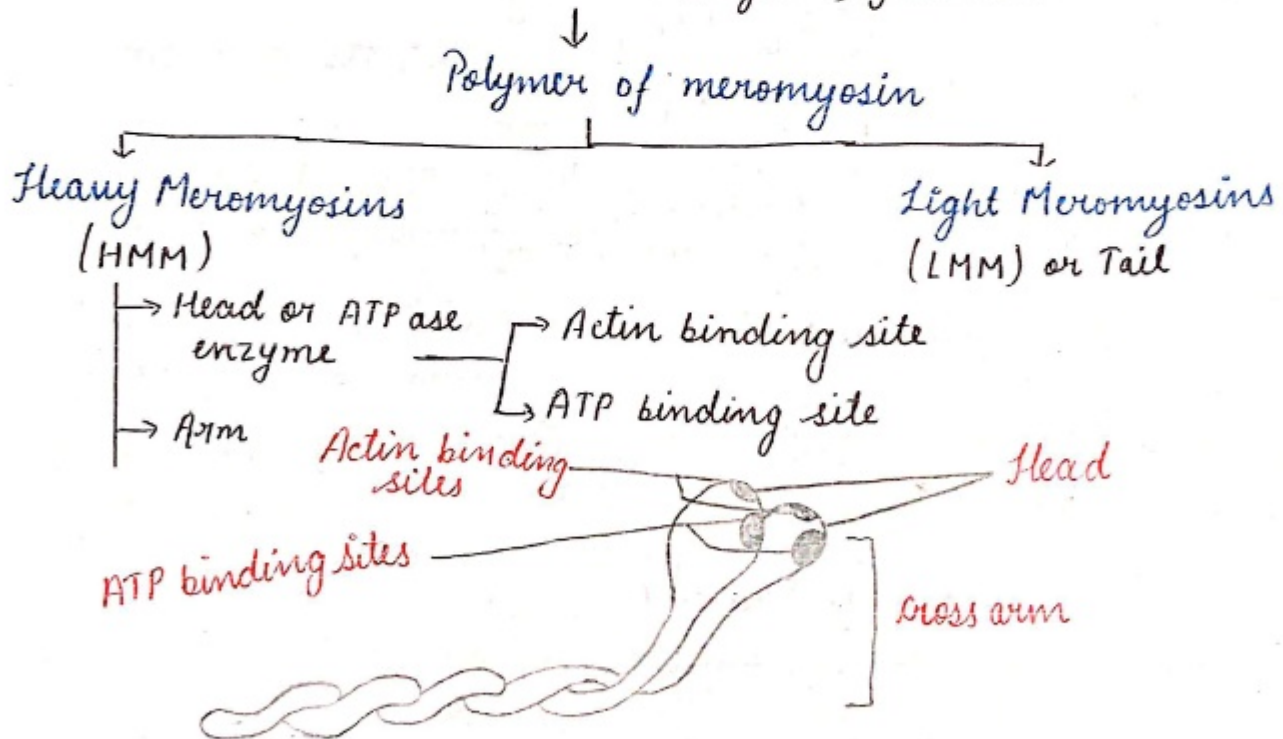
+ Structure of Contractile Proteins

STRUCTURE OF THIN FILAMENTS



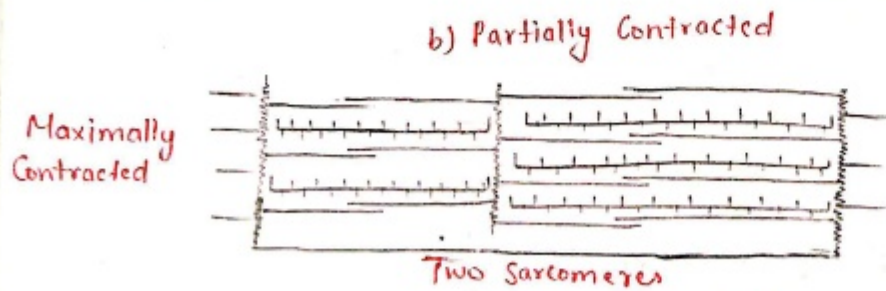
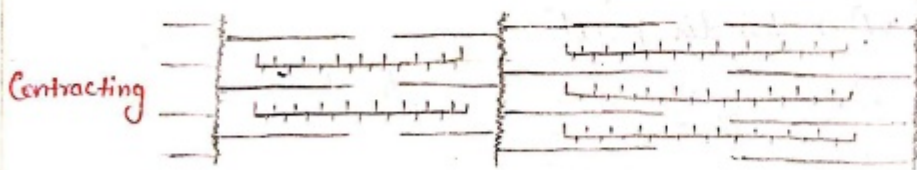
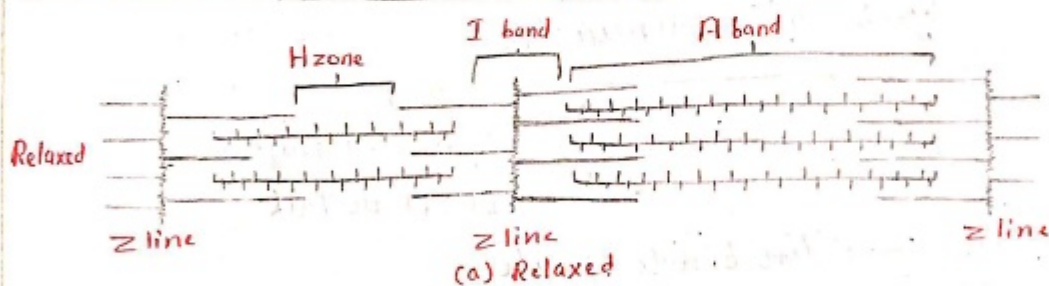
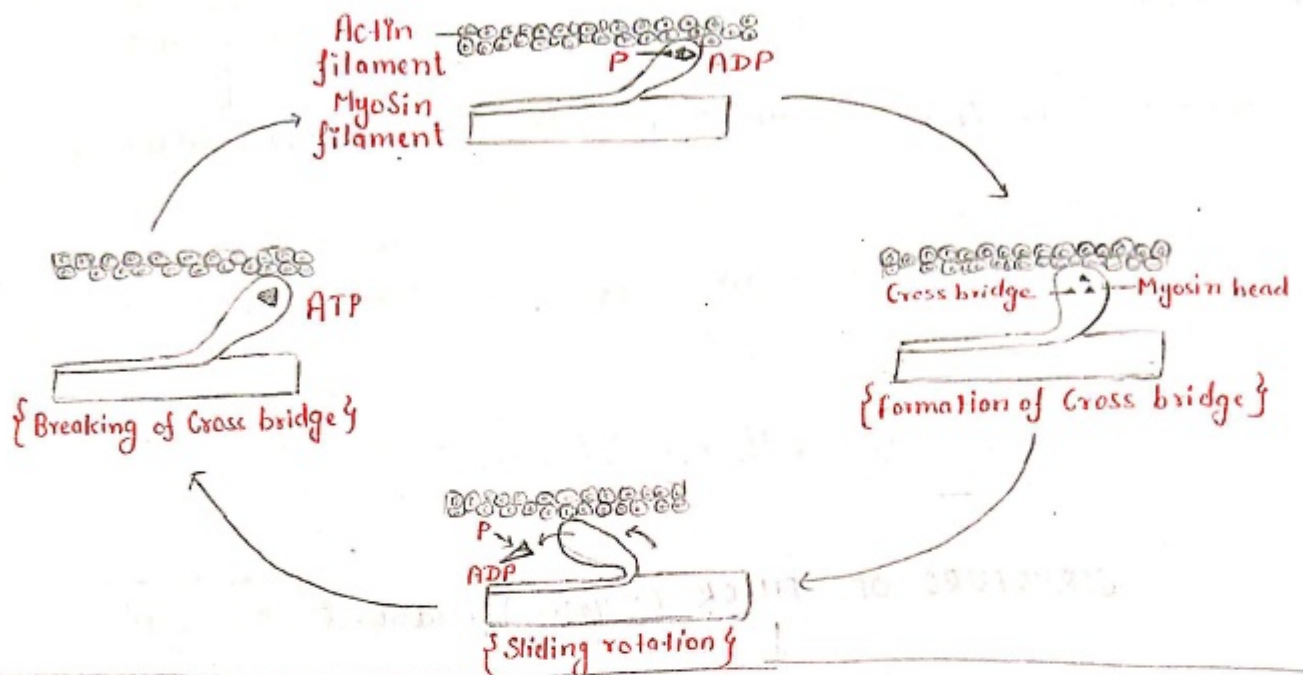
(a) An actin (thin) filament

STRUCTURE OF THICK (myosin) filament



(b) Myosin monomer (Meromyosin)

→ Mechanisms of Muscle Contraction and Relaxation.



(c) Maximally Contracted

→ Sliding filament Theory

→ Proposed by Huxley

Defⁿ: Actin filament slide over myosin filament.

Step of muscle Contraction & Relaxation

1) Nerve Impulse

→ Definition of motor end plate or neuro muscular junction

↓
→ It is the junction b/w motor neuron of efferent neuron & sarcolemma of muscle fibre.

• Motor neuron release acetylcholine at sarcolemma (neuromuscular junction)

↓
Depolarization of Sarcolemma

↓
Now Sarcoplasmic Reticulum → Release calcium ion (Ca^{+2}) in sarcoplasm.

↓
 Ca^{+2} bind with troponin, shift the tropomyosin, now myosin binding site open on Actin filament.

↓
Now myosin head with ATP bind with Actin form cross bridge.

↓
With the help of ATPase enzyme myosin head use ATP, release ADP + IP develop stroke due to myosin pull the actin (Actin slide over myosin)

↓
Now ATP bind with myosin head result in breaking of cross bridge

↓
Myosin head return to Original position (locked position) after ATP hydrolysis.

↓
 Ca^{+2} pumped back to sarcoplasmic Reticulum & tropomyosin cover the binding site again.

↓
Muscle Relaxed

+ Events during muscle contraction.

1) Sarcomere

↳ functional unit of muscle contraction
or,
Area b/w two Z-lines ↓ es.

2) H-zone ↓ es

3) A-band ↓ es ↗ vice versa

4) I-band neither ↑ es nor ↓ es

5) length of Actin & myosin filament not change.

→ ATP use both muscular contraction & Relaxation
(cross bridge formation & breaking)

→ Ca^{+2} only use for muscle contraction.

Skeletal System

→ made up of framework of bones and few cartilages.

→ plays an important role in body movement.

+ Cartilage

→ Intercellular material of cartilage is solid & pliable which resists compression.

→ Cells of cartilage are called chondrocytes - are enclosed in a small cavities (lacunae) within the matrix secreted by them.

→ Most of the cartilage in vertebrate embryos are replaced by bone in adults.

→ Cartilage is present in the :

1) Tip of nose

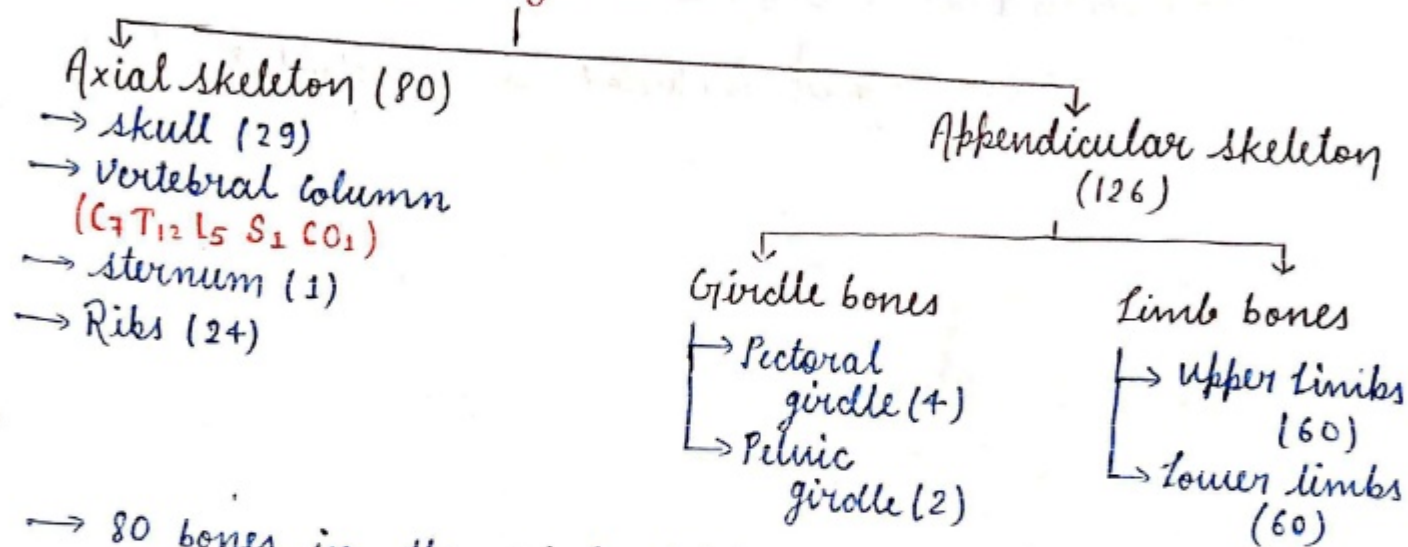
2) Outer ear joints

3) b/w adjacent bone of the vertebral column.

4) b/w bones of limbs and hand in adults.

- Bone has a very hard matrix due to calcium salts whereas chondroitin salts make the matrix of the cartilages pliable.
- Bone cell called Osteocytes
- In human, skeletal system is made up of 206 bones and few cartilages.
- Skeletal system is divided into main groups → the axial skeleton and the appendicular skeleton.

Skeletal system



→ 80 bones in the axial skeleton which are distributed along the main axis of the body.

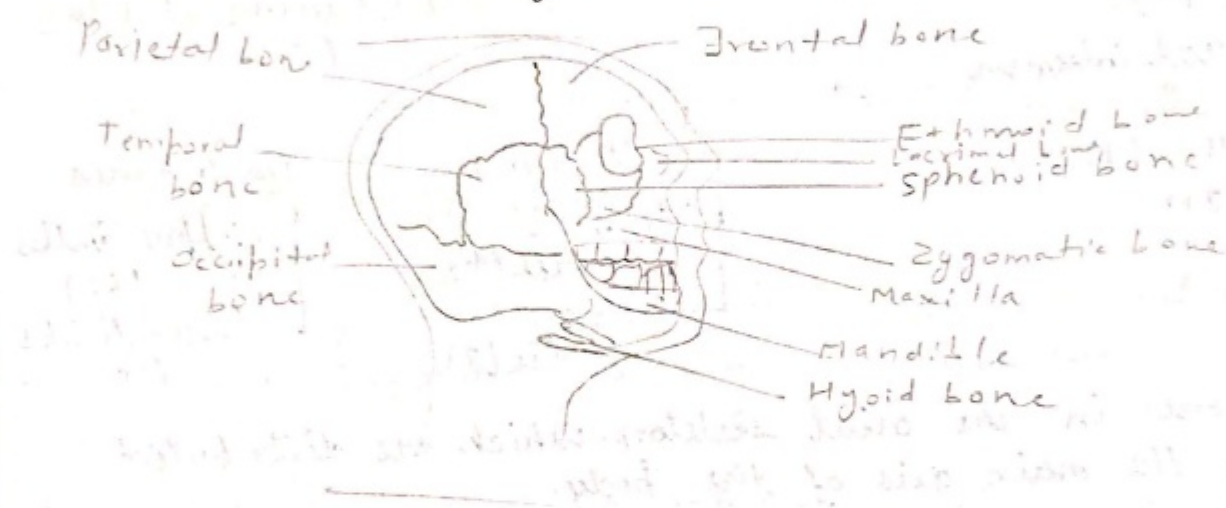
→ Axial skeleton (80 bones)

1. Skull	29 (8, 14, 1, 6)
2. Vertebral Column	26 (7, 12, 5, 1, 1)
3. Sternum	1
4. Ribs	24 (7, 3, 2 x 2)

Total ⇒ 80

→ Human Skull

- Skull is composed of two sets of bone ┌ Cranial
└ Facial
- Cranial bone is (8)
 - ↳ which makes the hard protective outer covering for the brain
- In facial part, there are 14 skeletal elements
 - ↓
form the front of the skull.
- A single U-shaped bone
 - ↳ Located at the base of buccal cavity.
 - ↓
Called Hyoid included in the skull & not join.



Diagrammatic view of human skull.

- Thus the skull consists of 29 bones as:

Cranial bones $\Rightarrow$ 8

Facial bones $\Rightarrow$ 14

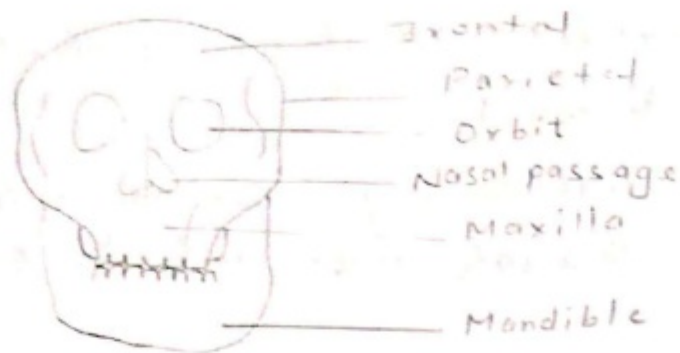
Hyoid bones $\Rightarrow$ 1

Ear ~~Ossicles~~ Ossicles $\Rightarrow$ 6

Total $\Rightarrow$ 29

collectively called Ear Ossicles

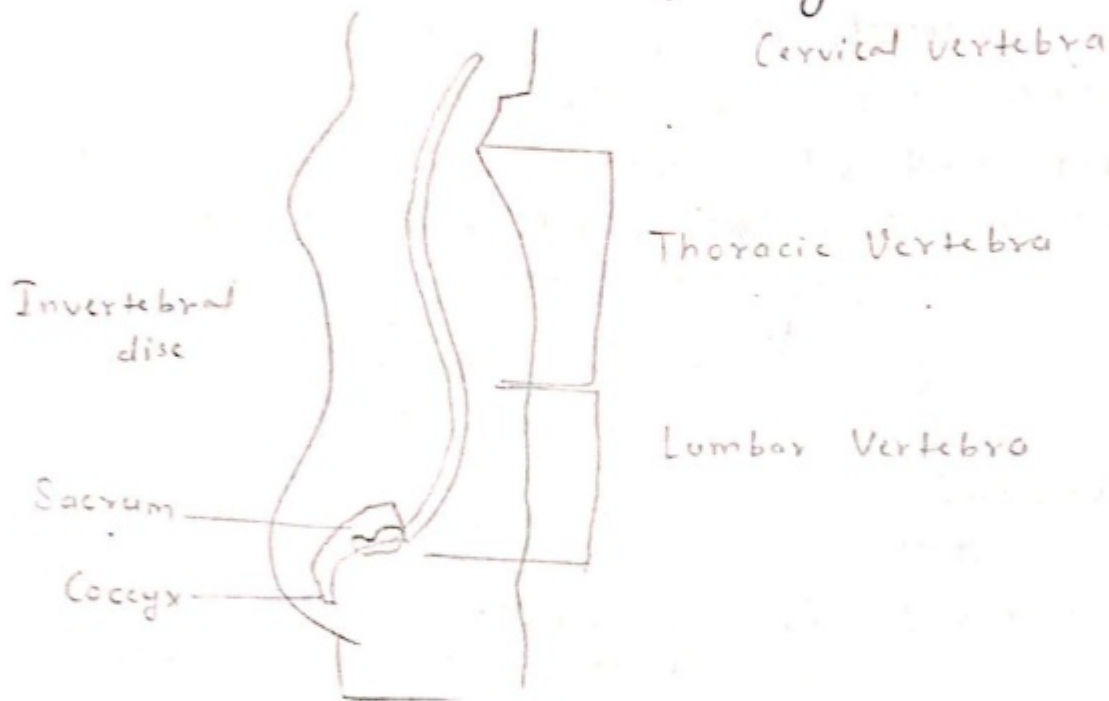
- In middle ear, 3 small bones $\rightarrow$ Malleus, Incus, Stapes
- Skull portion articulates the superior part of vertebral column with help of two Occipital condyles (dicondylic skull)



Frontal part

→ Vertebral Column (Back bone)

- Vertebral column made up of 26 serially arranged units called Vertebrae, located dorsally.
- Makes the main framework of body.



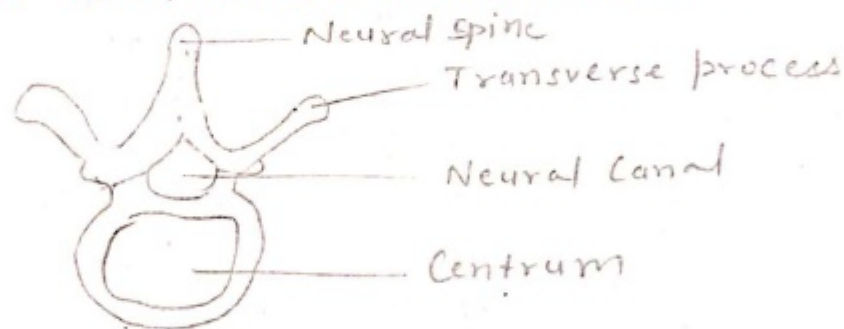
Vertebral Column

- Central part of each vertebra is hollow (neural canal) through which spinal cord passes.
- The first vertebra called Atlas
 - ↳ articulates with Occipital condyles.
- Vertebral Column is differentiated into the cervical (7), thoracic (12) lumbar (5) sacral (1-Fused) & the coccygeal (1-Fused)

- Cervical vertebrae is about seven of all mammals, including humans.
- The two neighbouring vertebrae articulate with each other through their anterior & posterior Zygapophyses.
- Intervertebral discs are present b/w the centra of two neighbouring vertebrae.

NOTE:

- The vertebral column forms the central axis of the body.
↓
keeps it erect.
- Encloses and protects the spinal cord
↳ provides surface for attachment of skull, ribs, pectoral and pelvic girdles, as well as several muscles in the neck, thorax, abdomen and waist.

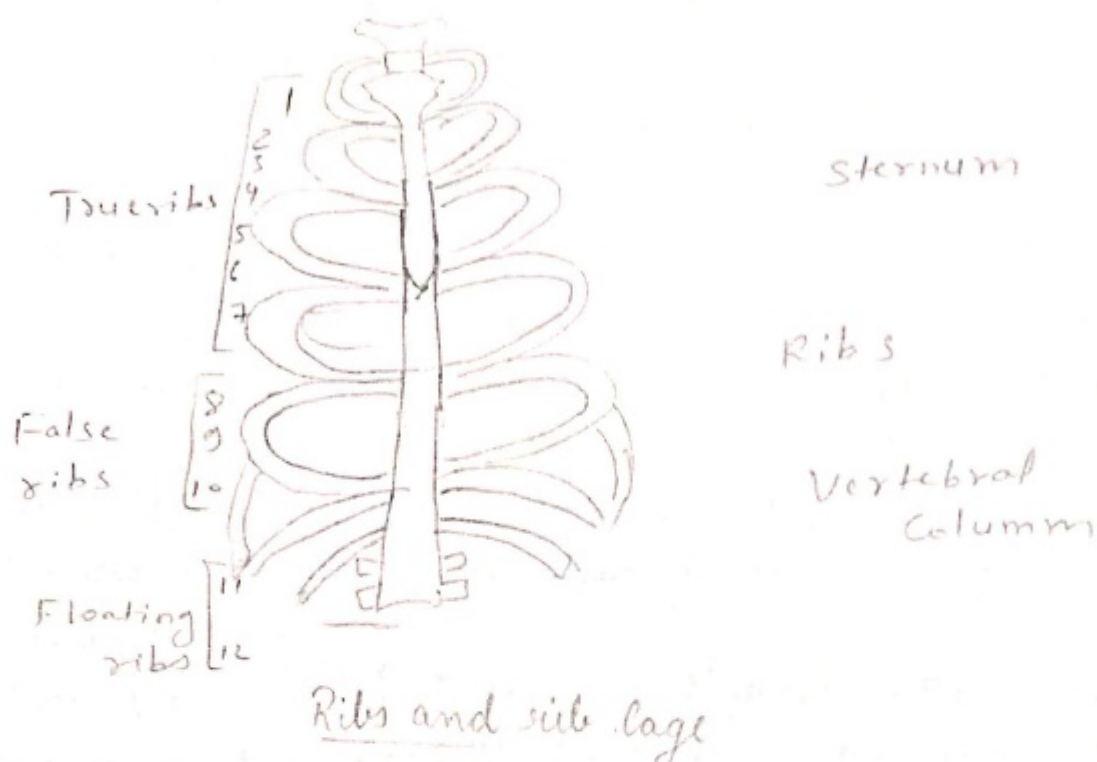


A typical Vertebra

+> Rib Cage and Sternum

- A flat bone located on ventral midline of thorax called sternum.
- 12 pairs (24) of ribs
↳ Thin flat bone connected with dorsally vertebral column & ventrally sternum.
- Two articulation surfaces on dorsal end, called **biciphalic**
- 8, 9 & 10th pair not directly attached with sternum, but help of hyaline cartilage join the 7th rib called Vertebrochondral ribs or false ribs.

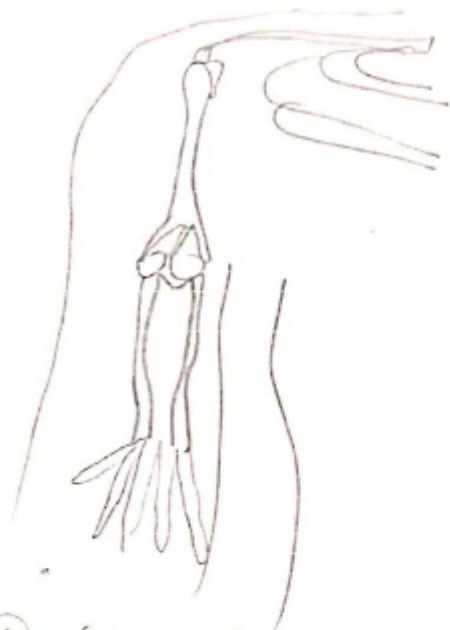
→ The last two pairs of ribs (11th and 12th) are not connected ventrally to the limb, so they are called floating ribs or vertebral ribs.



→ Bones of the hand or Fore limb.

- made up of bones → humerus, radius and ulna, Carpals, metacarpals & phalanges.
- Humerus is a straight bone with long shaft and forms upper arm.
- The head of humerus fits into glenoid cavity of Pectoral girdle.
- ★ → Crest at its proximal end form of deltoid ridge for attachment of arm muscles.
- ★ → The distal end has a foramen and trochlear process forms elbow joint with radius & ulna.
- Radius-ulna consist of 2 separate bones of forearm
- Ulna have olecranon process at its proximal end, which forms elbow joint with humerus.
- Carpals consist of 8 small bones forms wrist.
- Metacarpals made up of 5 long bones forming the palm of hand.

→ Phalanges consist of 2 in thumb, 3 bones in remaining 4 fingers. Totalling 14 bones.



Right pectoral girdle & upper arm.

→ Forelimb (30 bones)

- | | |
|----------------|-----------------|
| 1. Humerus | 1 |
| 2. Radius | 1 |
| 3. Ulna | 1 |
| 4. Carpals | 8 (wrist bones) |
| 5. Metacarpals | 5 (palm bones) |
| 6. Phalanges | 14 (digits) |

Total	30
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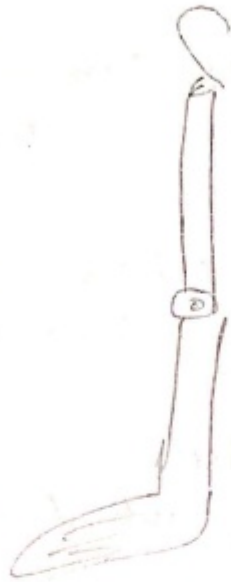
→ Bones of the leg or Hind Limb

- made up of femur, tibia, fibula, patella (knee cap), tarsals, metatarsals, Phalanges.
- Femur is the longest bone.
 - ↳ head of femur fits into acetabulum of pelvic girdle.
- # The proximal end has trochanters for attachment of thigh muscles.
- # The distal end has two condyles, which articulate with triangular shaped patella and proximal part, tibia to form knee on ventral side.
- Tibia is more developed than fibula
 - ↳ Its proximal end articulates with femur & Patella & forms knee.
- There are 7 tarsal bones, arranged in two rows to form ankle. Largest bone is calcareous which form heel.
- Metatarsals consist of 5 bones & form foot.
- Phalanges consist of 2 bones in big toe & 3 bones in each remaining toes thus totalling 14 bones.
- Hindlimb (30 bones)

Femur	1 (thigh bone)
Tibia	1
Fibula	1
Tarsals	7 (ankle bones)
Metatarsals	5
Phalanges	14 (digits)
Patella	1 (cup-shaped)

Total → 30

- A cup shaped bone called Patella cover the knee ventrally (knee cap).
- girdle is formed of two halves.



Right pelvic girdle

+ Pectoral Girdle / Shoulder Girdle

- Consist of clavicle and a scapula.
- Scapula a large triangular flat bone in the dorsal part of thorax b/w the second & seventh ribs.
- Scapula has a slightly ridge called the spine as a flat, called the acromion. clavicle articulates with this.
- Below acromion a depression called glenoid cavity which articulates with the head of humerus to form the shoulder joint.
- A long slender bone with two curvatures, commonly called collar bone.

→ Pelvic girdle

→ Consist of 2 Coxal bones.

↓
each coxal bone formed by fusion of 3 bones

→ ilium
→ ischium
→ pubis

- At the point of fusion of above bones is a cavity called acetabulum to which thigh bone articulates.
- Two halves of Pelvic girdle meet ventrally to form the pubic symphysis containing fibrous cartilage.

NOTE:

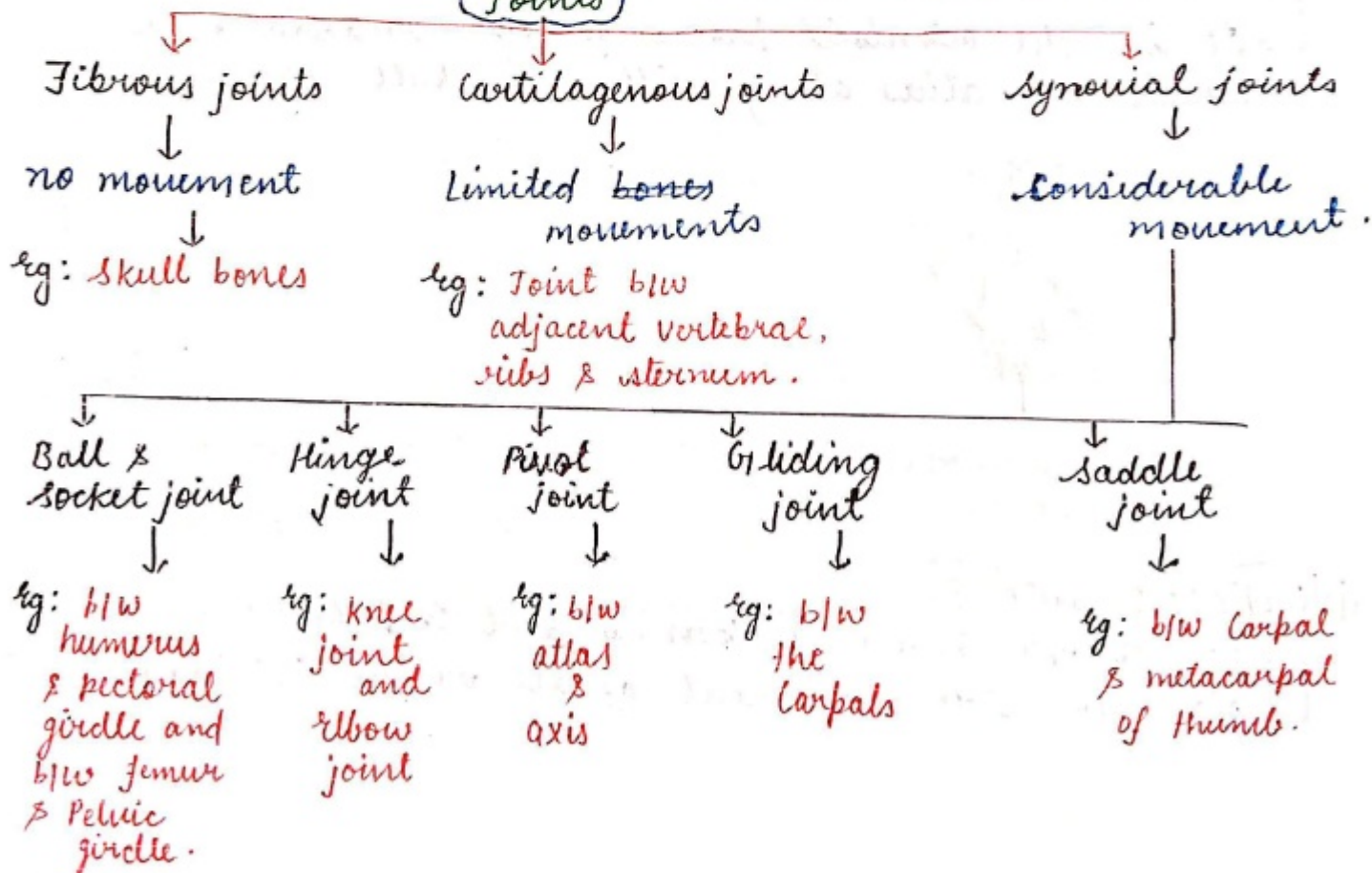
Pelvic girdle commonly called hip bone.

Joints

→ between bones or b/w bones and cartilage.

→ joints acts as a fulcrum

Joints



+ Fibrous joints

- not allow any movement
- Shown by the flat skull bones fuses end to end with the help of dense fibrous connective tissue in form of sutures, to form cranium.
- b/w pubic bones of pelvic girdle, fibrous joint is found.

+ Cartilaginous Joints

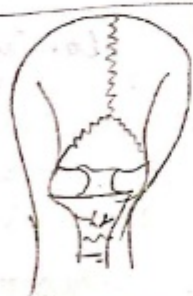
- bones involved are joined together with help of cartilages.
- joint b/w the adjacent vertebral, the vertebral column permits limited movements and joint b/w ribs & sternum.

+ Synovial Joints

- characterized by presence of a fluid filled synovial cavity b/w articulating surfaces of two bones.
- help in locomotion & many other movements.

i) PIVOT JOINT

- b/w atlas and axis called atlanto-axial joint.
- allow rotational movement.
- It is the odontoid process of axis vertebra over which the atlas along with the skull rotate.



Pivot joint.

ii) GLIDING JOINTS

- found b/w bones of tarsals and carpals.
- side-to-side movement of all or few joining element.

iii) **SADDLE JOINTS**

↳ b/w carpal and metacarpal of thumb
(carpometacarpal joint of thumb)

iv) **HINGE JOINTS**: knee joint, elbow joint, Interphalangeal joint
(between Phalanges)

↳ allow movement in one plane only.



v) **SADDLE JOINT**

↳ allow movements in two planes.

↳ found in bones of metacarpals & carpals of thumb.



vi) **BALL & SOCKET JOINTS**

↳ b/w humerus & glenoid cavity of pectoral girdle
(shoulder joint)

↳ b/w femur & acetabulum of pelvic girdle
(hip joint)

↳ allows movement in more than two planes.

↳ Malleus with incus (in ear ossicles)



→ Disorders of Muscular and Skeletal System

- 1.) Myasthenia : An autoimmune disorder affects neuromuscular junction or motor end plate resulting in fatigue, weakening and Paralysis of skeletal muscles.
- 2.) Muscular dystrophy : An autosomal dominant disorder degeneration of skeletal muscles due to genetic disorders.
- 3.) Tetany : Rapid spasms or contraction in the muscle is due to low calcium ions in body fluid or blood due to mycobacterium tetany and more Calcium in muscle.
- 4.) Arthritis : Inflammation of joints (*Rheumatoid Arthritis*)
- 5.) Osteoporosis : age related disorder has a high probability of fracture due to decrease in bone mass.
"A common cause is the decreased estrogen level in old age in female"
- 6.) Gout : Inflammation of joints due to the accumulation of uric acid crystals.