Handwritten Notes

on

Locomotion and Movement

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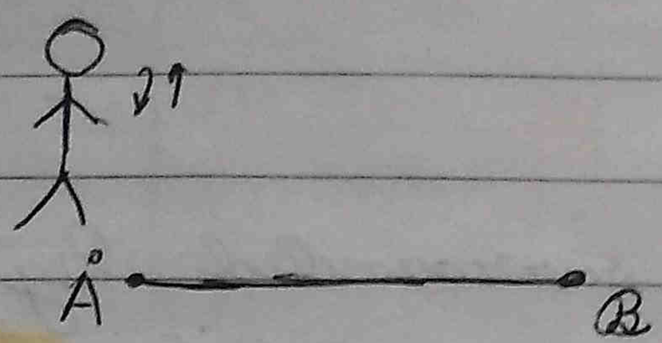
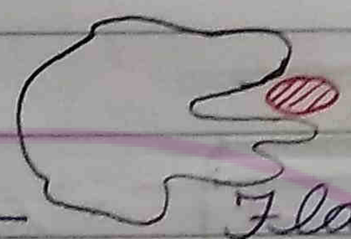
Locomotion and Movement



- Amoeboid movement with the help of pseudopodia
  e.g Amoeboid, WBC



- Ciliary Movement — Flagellar Movement :
  e.g Paramecium
  Sperm

- Muscular Movement → with the help of muscular tissue

- Skeletal muscle —
  Striated, Voluntary

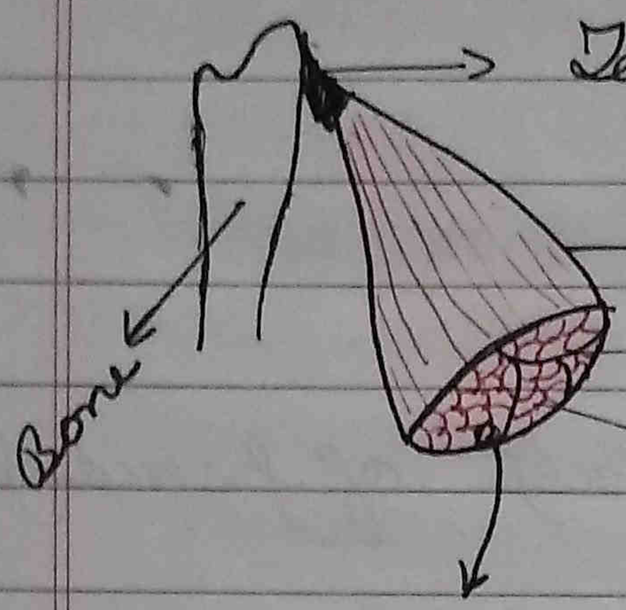
  - Attached to bones by help of tendons.

- Cardiac Muscle —
  Striated, Involuntary, Branched.
  Present in heart wall.

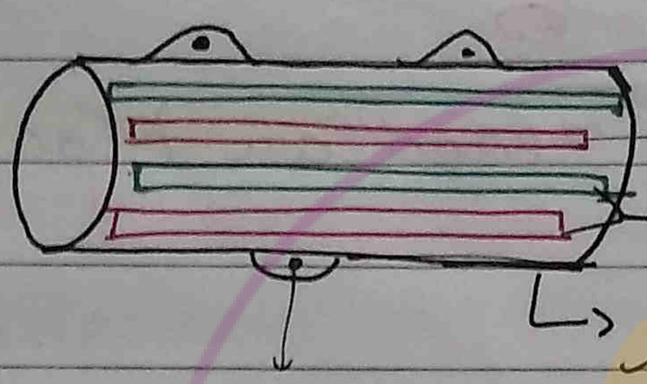
- Smooth Muscle —
  Unstriated, Involuntary
  Present in visceral organs.

- Anisotropic → having substances with different refractive index

- ## Skeletal Muscle



→ Muscle : surrounded by Epimysium
→ Fascile : surrounded by Perimysium
→ Muscle cell/fibre - surrounded by Endomysium



→ Sarcoplasm (cytoplasm)
→ ★ myofibrils
→ Sarcolemma

Nucleus.

- Sarcosomes → Mitochondria ✓

- Sarcoplasmic Reticulum → Endoplasmic Reticulum (smooth) ✓

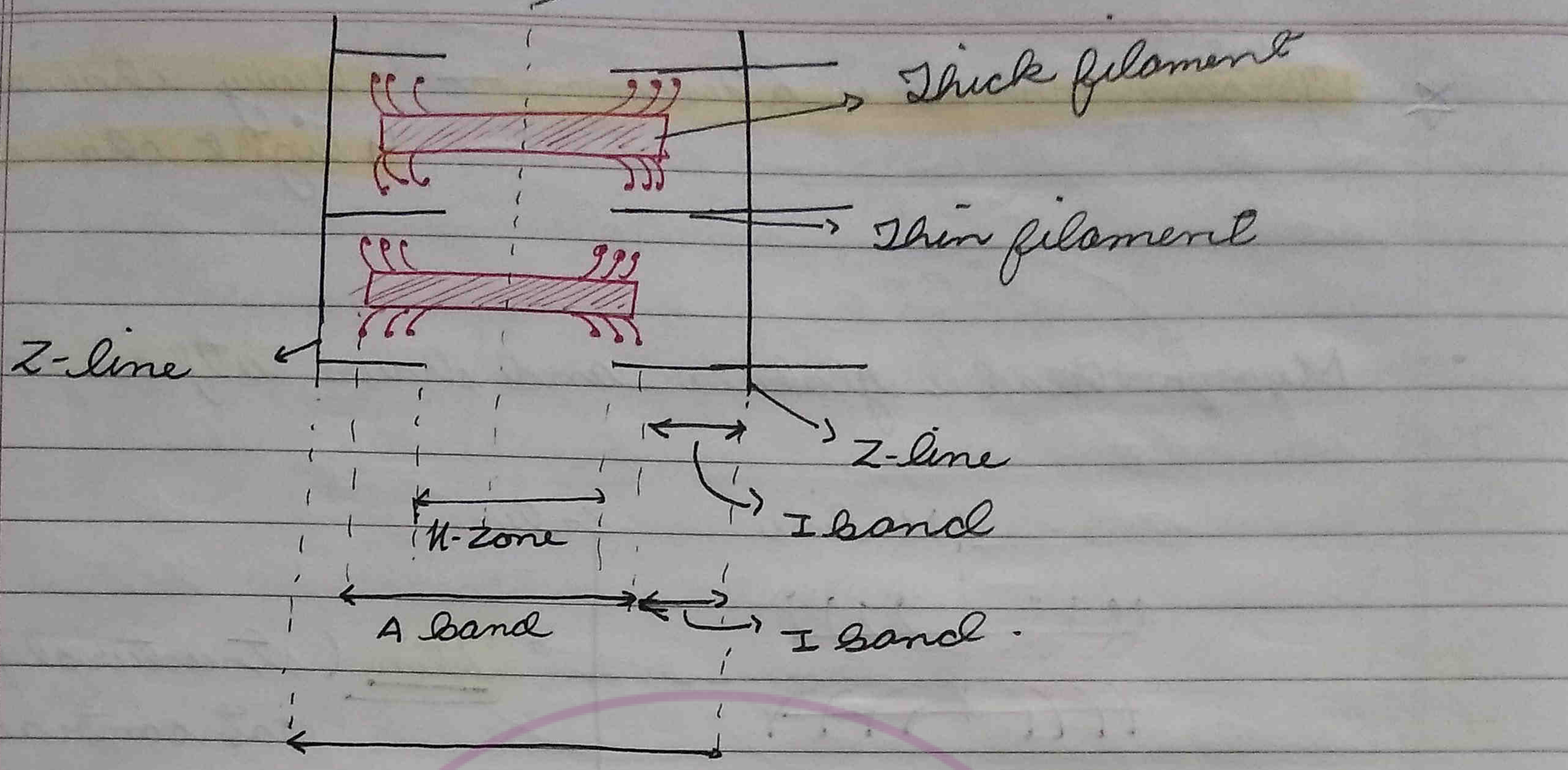
Muscle cell
↓
Myofibrils
↓
Protein filaments
↓ ↓
Thick filaments Thin filaments

- ## Muscle cell

A-band (Anisotropic band)

region b/w two Z-lines = sarcomere.

- Myosin is polymerised from many ~~meromer~~ monomeric proteins called meromyosin.

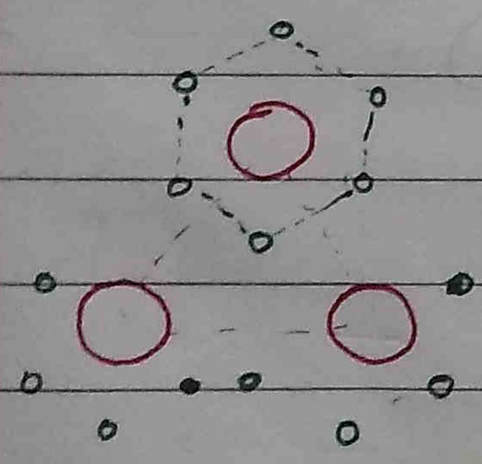


Sarcomere → fundamental unit of muscle

- /

- Thick filament + overlapping thin filament
- Appears dark under microscope.

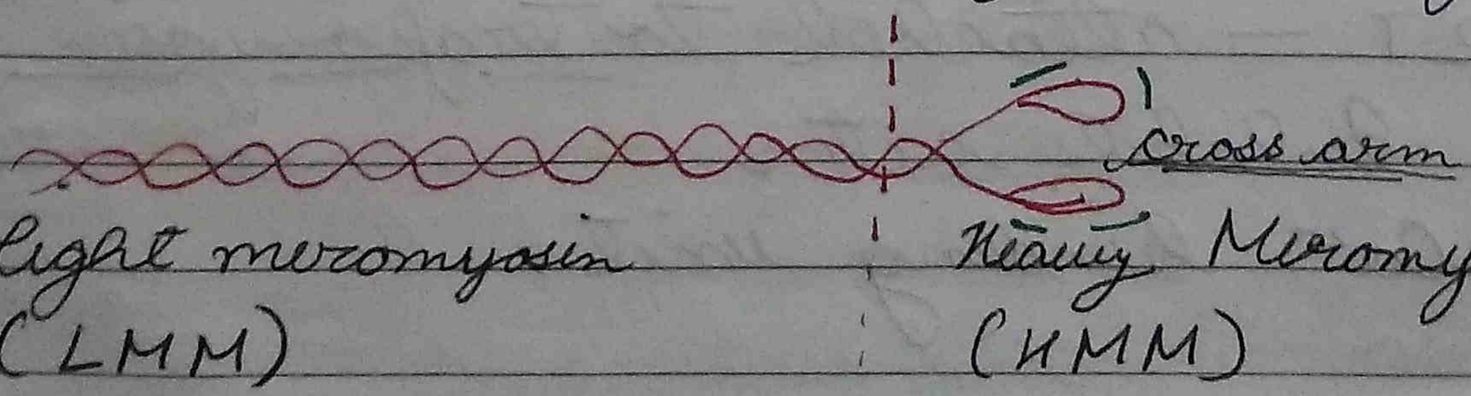
- I band (Isotropic)
- Thin filament present
- Light in colour.



- Each thick filament surrounded by 6 thin filaments.
- Each thin filament surrounded by 3 thick filaments.

- Muscle Proteins

Myosin protein → makes up thick filament

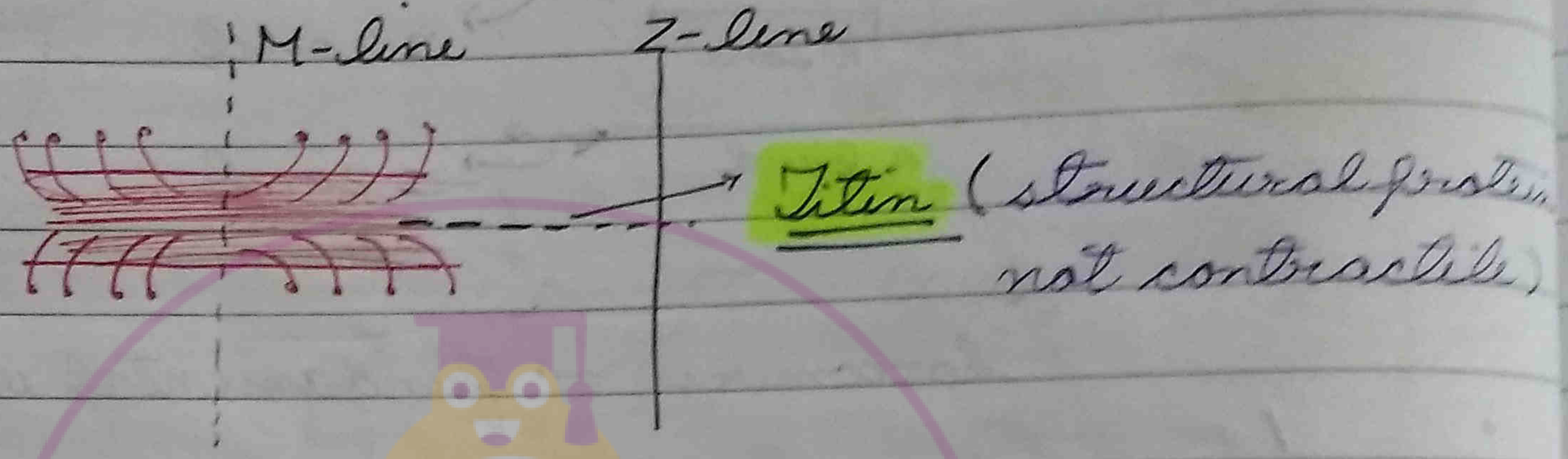


- Myosin ~~protein~~ are held together by M-line protein and attached to Z-line by Titin protein.

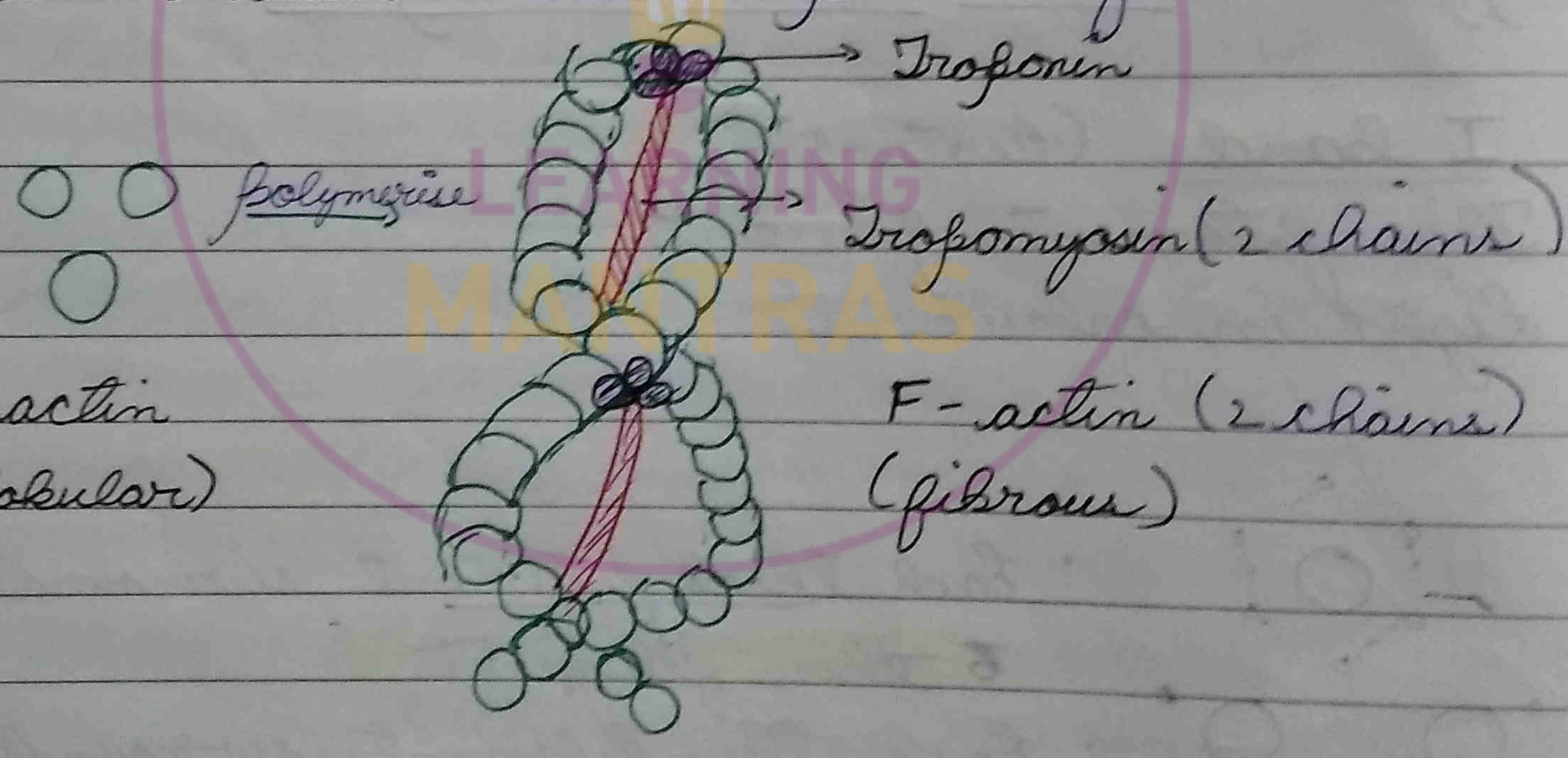
★ Titin → largest size protein in body.

★ 1 Myosin protein molecule is a hexamer — 2 heavy chains
— 4 light chains

- Myosin head is globular and shows ATPase activity.



- Actin Protein → makes up thin filament.



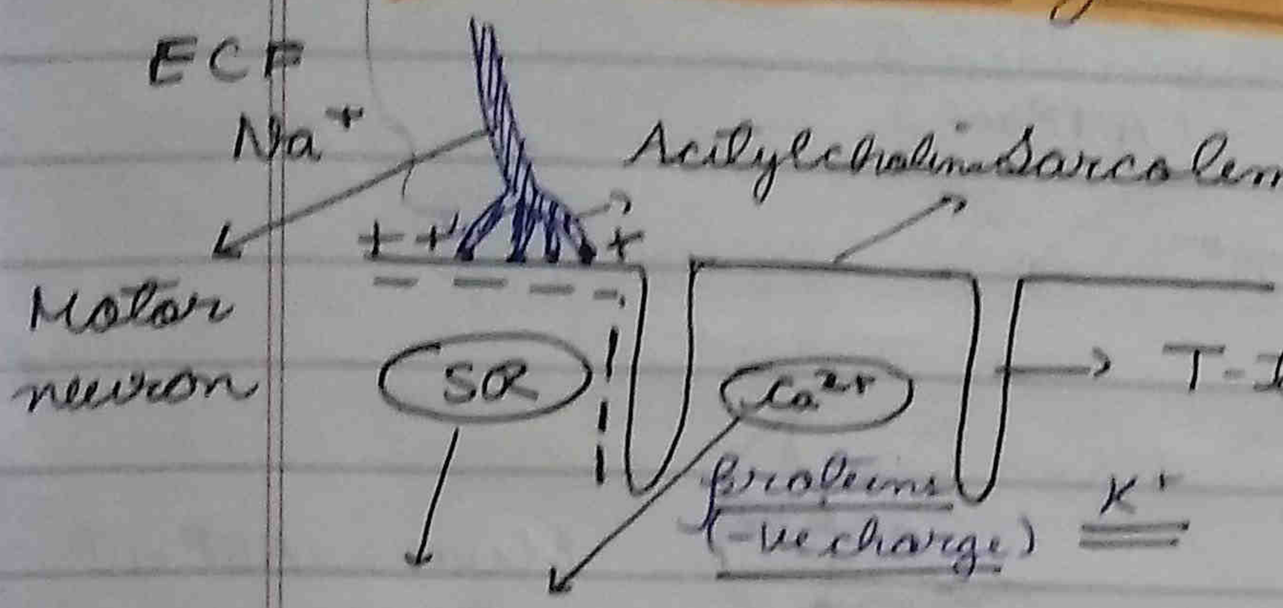
- Tropomyosin → fibrous protein
  - Covers the actin sites during relaxed state.

- Troponin — globular
  3 units
  TnT / TpT — attached to tropomyosin
  TnI → Inhibits actin
  TnC → Ca^{2+} binding unit.

Tn = troponin

Sarcotubular system is not present in smooth muscles.
Sarcoplasmic reticulum acts as Ca^{2+} reservoir.
Myoneural junction : junction of sarcolemma and motor neuron.

- **Sarcotubular System** : consists of sarcoplasmic reticulum (SR) and T-tubules.



- T-tubule : invaginations of sarcolemma at A-I band junctions in skeletal muscles and (at Z-lines in cardiac muscles)

Cisterne of sarcoplasmic reticulum

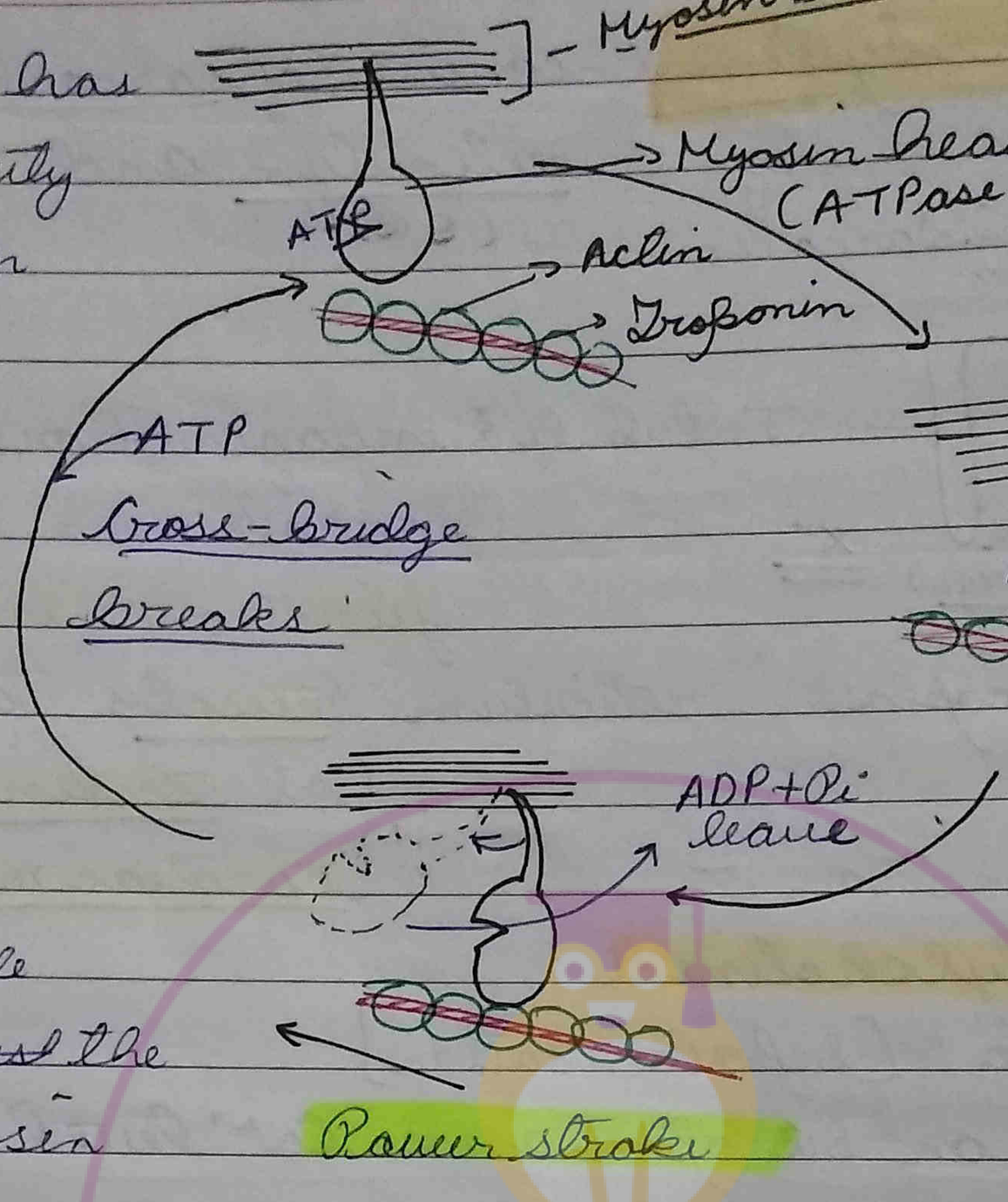
- Myoneural junction —
  - Release of acetylcholine
  - Influx of Na^+ [depolarisation]
  - Ca^{2+} channels on SR open and Ca^{2+} level in sarcoplasm rises.

Muscle Contraction

- Release of Ach from motor nerve endings.
- Sarcolemma is depolarised.
- Action potential passes through T-tubule.
- Ca^{2+} channels on SR open hence there is exit of Ca^{2+} from SR to sarcoplasm.
- Ca^{2+} binds to Troponin (TnC)
- TnC undergoes conformational change and Tropomyosin is shifted.
- Actin sites become free to bind with myosin.

- Myosin has low affinity when ATP is attached to it.
- ACHE inhibitors lead to continued contraction of muscles since acetylcholine won't degrade.

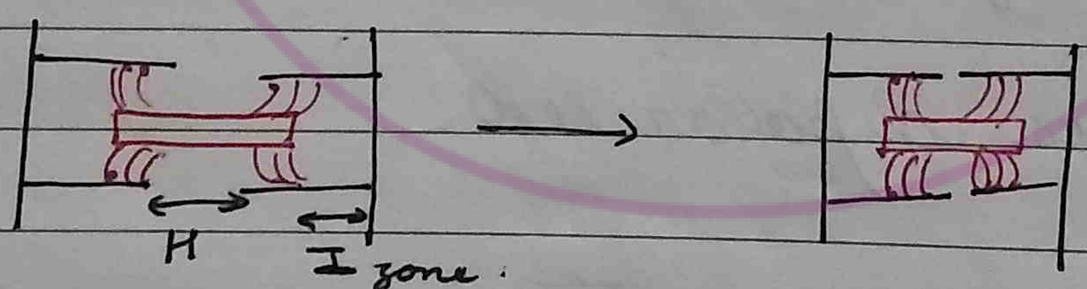
Myosin has low affinity for actin



only head of myosin molecule move, not just the whole myosin

Sliding Filament Theory - Huxley and Huxley

- Thin filaments slide over thick filament.



- Sarcomeres - decrease in length ✓
  I - band decreases ✓
  H - Zone decreases ✓

- ✡ A-bands and M-line remain unchanged. ✓

✡ → Acetylcholine $\xrightarrow[\text{Acetylcholine Esterase (AchE)}]{\text{Breakdown}}$ Acetic acid + Choline] reabsorbed by synaptic nobs.

- DFP (Diesopropyl fluorophosphate), Nerve gas, Insecticides, Irreversible AchE.

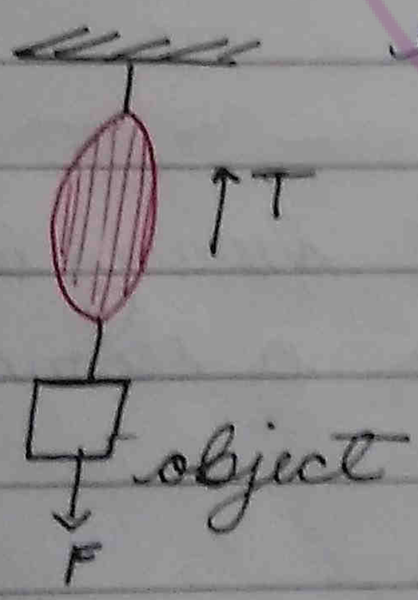
- Types of Contraction

1 Isometric Contraction
same length

- No change in muscle length during contraction.
- ✱ Work done is zero (muscle is generating force but there is no change in length)
e.g Pushing a wall.

2 Isotonic contraction
same tension

- Tension is force generated by muscle.
e.g lifting an object.



- Muscle Response

Threshold stimulus → minimum strength of stimulus which causes a muscle fibre to contract.

- Skeletal muscle fibre have shortest refractory period hence tetanus is possible
- Muscle has many muscle fibres having different threshold stimulus.

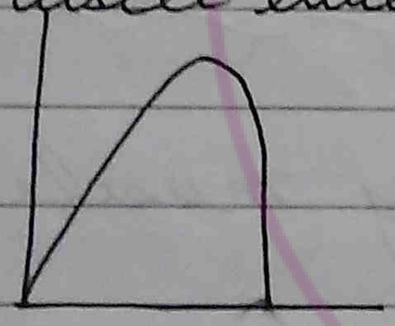
- All or None law : If a threshold stimulus is applied to muscle fibre, it contracts maximally. This law is not applicable for complete muscle.

- Muscle Twitch → Single contraction followed by relaxation due to stimulus.

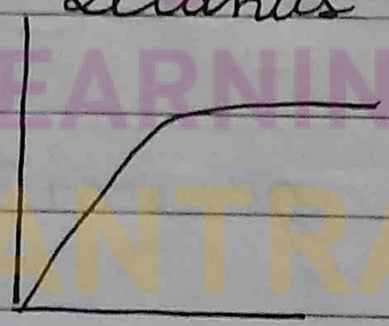
- Tetanus → sustained contraction due to repeated stimuli
"Summation of contraction" e.g holding a pen.
("not diseased condition")

- Treppe → repeated contraction due to subtetanizing stimuli.
(less stimuli than Tetanus)

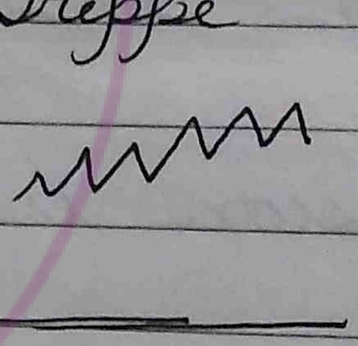
Muscle twitch



Tetanus



Treppe



- Refractory period → Time period during which a muscle fails to respond for a second stimulus.

- skeletal muscle fibre 0.002 – 0.005 s
- Cardiac muscles have longest refractory period of 0.1 – 0.2 s.

- Myoglobin : store oxygen SER store glycogen
- No. of muscle fibres is genetically determined
- Red muscle fibres are narrow as compared to white muscle fibres (broader).

Skeletal Muscle fibres

Red fibres	White fibres
Type I	Type II
Narrow diameter	Broder diameter
High Myoglobin	No Myoglobin
No of mitochondria is high	low
less smooth endoplasmic reticulum	More smooth endoplasmic reticulum.
Slow, oxidative fibres	Fast oxidative glycolytic fibres.
Lactic acid does not accumulate easily.	Lactic acid quickly accumulates
Do not fatigue easily.	Muscles fatigue easily.
e.g back muscles flight muscles of long distance flying bird muscls of kite	e.g muscles of eyes, eye lids flight muscle of short distance flying birds such as sparrow.

- Red fibres - more developed in a Marathon runner (42.2 km). Narrow diameter
- White fibres - more developed in a 100 m sprinter. Broader diameter

- Presence of Creatine Phosphate is characteristic feature of vertebrates and is used as energy source.
- Glycolysis is main source of energy in white fibres.

Energy Source for Muscle Contraction

(i) - ATP

(ii) - Creatine Phosphate : Phosphagen stored in muscles synthesised in liver which releases Phosphate ions.

during activity ⇒ Creatine + ADP $\underset{\text{Kinase}}{\overset{\text{Creatine}}{\rightleftharpoons}}$ Creatine + ATP
Phosphate

- Creatinase is converted to Creatinine $-PO_4$ during rest but some Creatine is lost as its anhydride called Creatinine.

Creatinine passes out in urine.

- Creatine is formed in liver from 3 amino acids i.e Glycine + Arginine + Methionine.

(iii) Glycolysis = Glucose is broken down to Pyruvic acid and energy is released.

- Oxidative Phosphorylation : Pyruvic acid enters Krebs cycle Aerobic muscle / red fibres.

- Oxygen Debt : Rate of respiration remains high even after strenuous exercise is stopped.
  - Metabolic rate remain high so that body

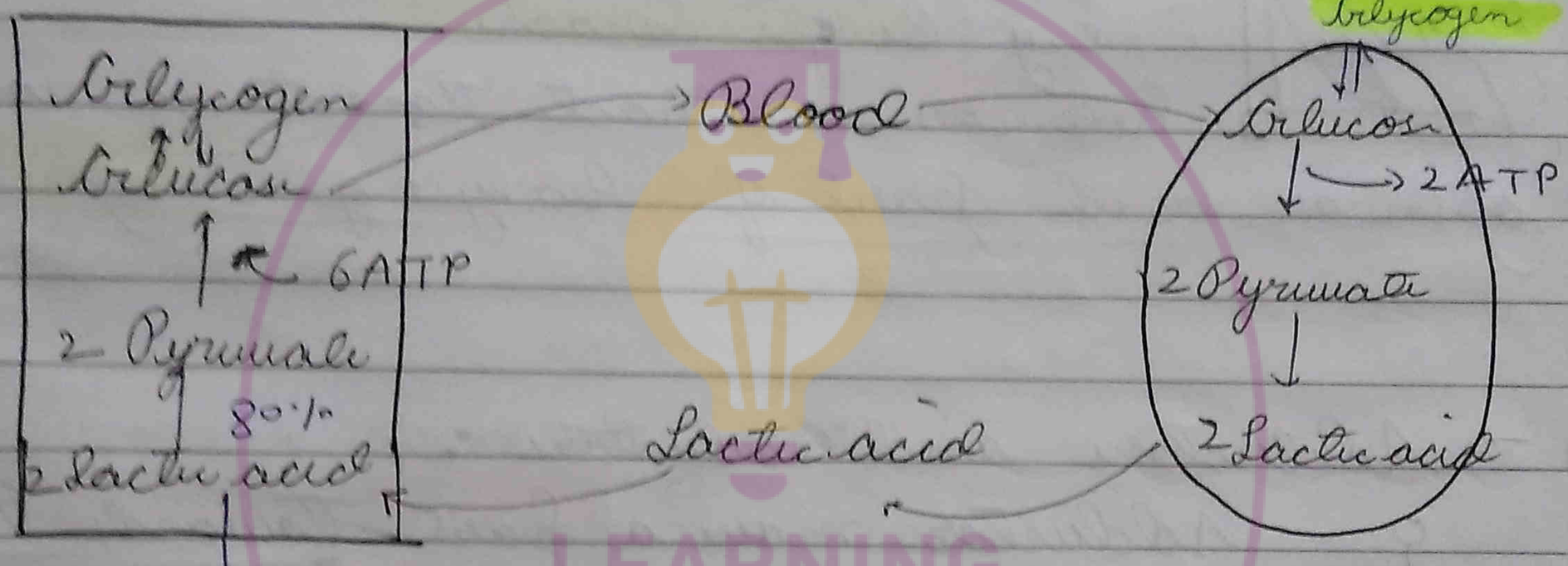
- Glycogen cannot be transferred from liver cell as its molecular size is large hence converted into glucose
- Cori Gerty Cori and then transferred

respirable. The lost resource within the muscles. like O_2. Glycogen.

Cori's Cycle

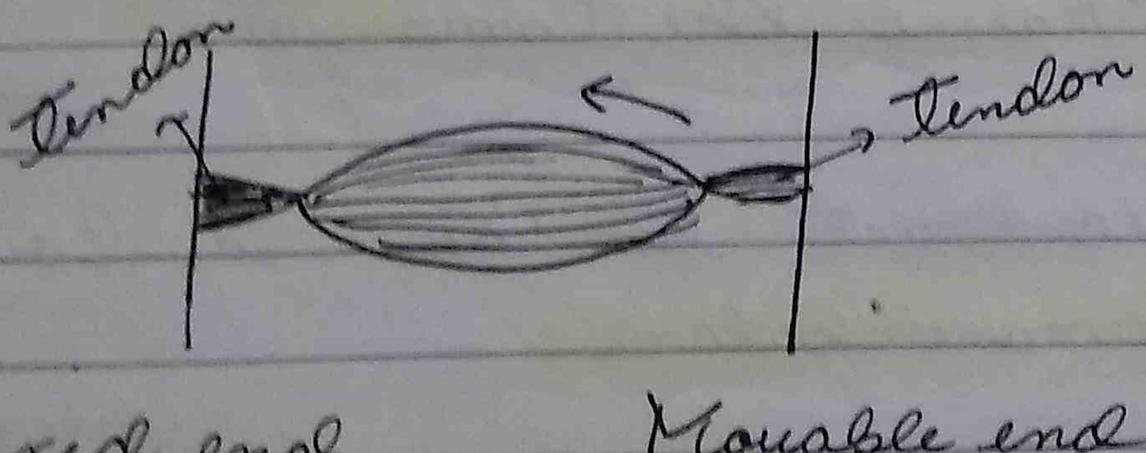
Gerty Cori, Carl Cori
1947 Nobel Prize.

- 80% of lactic acid formed is reused.



- Muscle fatigue → Inability to contract muscle as accumulation of lactic acid, desensitizes the muscle fibre.

Muscle Groups



fixed end
↓
Origin

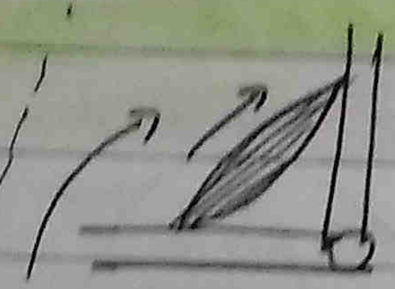
Movable end
↓
Insertion

There are 639 muscles in human body, out of which 317 are paired and 5 are unpaired.

- Synergists: A muscle along with another muscles contracts to produce movement in same direction.

- Antagonists: Two different sets of muscles which produce different movements.

(a) - Flexors and Extensors: Flexors contract to bend one part over other
e.g Biceps brachi



Extensors contract to extend or open a bend part of body e.g Triceps

(b) - Adductors and Abductors:

Adductors move a part towards the body axis
e.g Latissimus dorsi
Abductors move a part away from body axis
e.x Deltoideus.

(c) - Levators and Depressors:
- Levators contract to raise a body part.
e.g Masseter - raises the lower jaw.

- Depressors contract to lower a body part
e.g Depressor mandibularis

(d) - Pronators and Supinators:
- Pronators - rotate the palm so that it faces downwards.
- Supinators - rotate the palm so that it faces

- Muscle disuse leads to weakening and then atrophy.

upwards.

☆ • Strongest muscle — Masseter.

• Longest muscle — Sartorius

• Longest muscle group — Quadriceps femoris.

• Largest muscle — Orbitus maximus.

• Smallest muscle — Stapedius.

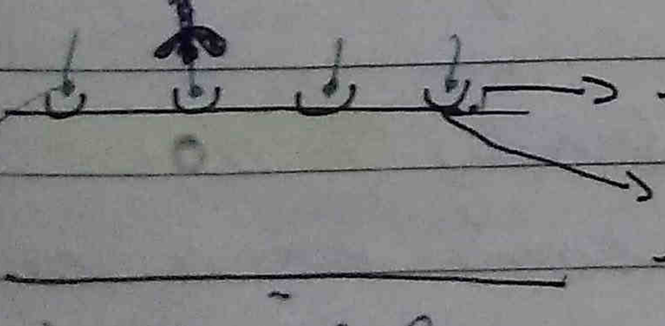
• Disorders

1 Muscular Dystrophy (MD)
- Genetic disorder.
- Dystrophin protein is not formed.

- Dystrophin protein is present between muscle fibres and necessary for coordinated contraction of different muscle fibres in a bundle.

- X-linked disease
- Duchenne MD — fatal by the age of 30 years.
- Becker's MD — milder.

2 Myasthenia Gravis
Autoimmune disease



antibodies bind hence acetylcholine cannot bind.

- Haemopoiesis → formation of blood cells

- Antibodies are formed that bind to Ach receptors which leads to muscle weakening and atrophy.

3 Poliomyelitis / Polio

- caused by RNA virus
- Mode of infection is faeco-oral route.
- Multiply in intestine and move to spinal cord.
- Destroy ventral horn of spinal cord where motor nerves are situated.
- Hence motor neurons cannot send messages to the muscles which leads to Paralyses.

Skeletal System

consists of Bones and cartilage.

Bones

- They form frame work of body.
- help in locomation and movement.
- Bone marrow present in bones is involved in Haemopoiesis.
- ✡ Bones are Ca^{2+} reservoir of the body.
- Total bones in human body = 206
  but in children = 213 as some bones are free.

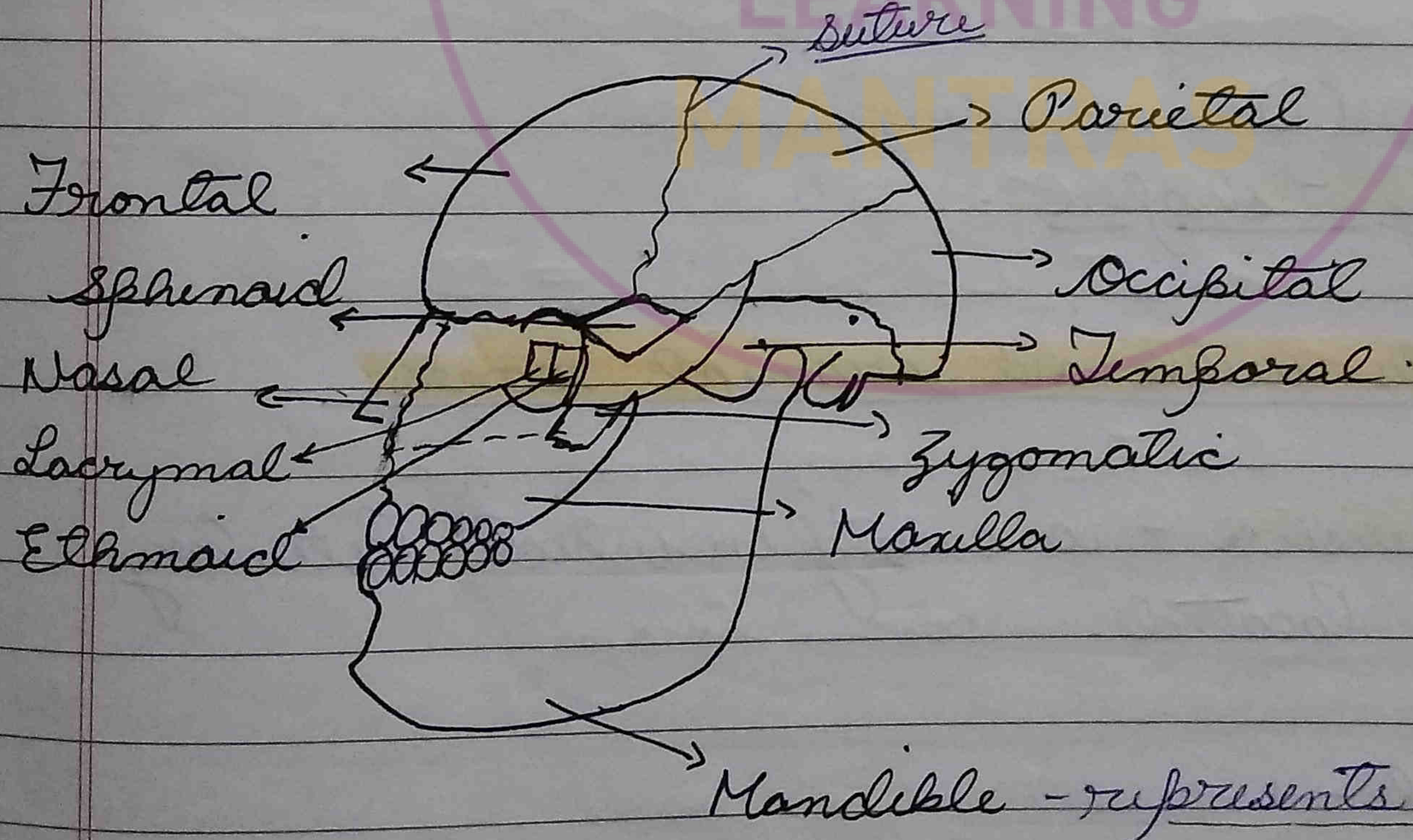
Skeleton (206 bones)

Axial Skeleton (80)
- skull
- Vertebral column
- sternum
- ribs

Appendicular skeleton (126)
- girdles
- limbs

- Skull

Cranium (Brain box) - 8
Facial - 14
Hyoid - 1
Ear ossicles (middle ear) - 6



- Cranial bone (8)

Frontal (1): forms roof of forehead and roof of eye-orbit.

· Only mammals and amphibians are dicondylic.

· Parietal (2): forms roof of cranium.

· Occipital (1): It has Foramen of Magnum which is an aperture through which spinal cord emerges.
It has 2 occipital condyles (∽ ∽) hence called Dicondylic.

· Temporal (2): an aperture, external auditory meatus is located here.

· Ethmoid (1): Forms roof of nasal cavity.
Gives rise to 2 turbinates / nasal conchae which project into nasal cavity i.e Superior and ~~Inferior~~ Median nasal conchae.

· Sphenoid (1):
- Butterfly - shaped.
- Articulates with all cranial bones.
- Sella Turcica - a cavity in which Pituitary gland is located.

Frontal - 1
Parietal - 2 (pair)
Occipital - 1
Temporal - 2 (pair)
Ethmoid - 1
Sphenoid - 1

- Mandible is the only movable bone in the skull.
- Mandible is made up of more than 1 bone in lower animals.
- ★ Presence of 3-ear ossicles is mammalian trait.

- Facial Bones (14)

Nasals (2) - nose bridge
Infra nasals (2) - nose bridge inferior nasal conchae
Lacrymals (2)
Palatine (2)
Vomer (1)
★ Zygomatic (2) - cheek bones
Maxilla ★(2) - upper jaw
Mandible (1) - lower jaw.

- Jaw Suspensorium

- Upper jaw is fused with cranium.
- Lower jaw (mandible) articulates with temporal.

- Mammals have CRANIOSTYLIC jaw suspension in which jaws are hanging from cranium.

- Hyoid
(Tongue bone).
- Located between lower jaw and larynx.
★ Does not articulate with any other bone.
- ✓ Provides insertion to some of the tongue muscles.

- Ear Ossicles
3 ear ossicles present in each middle ear.

★ Hyomandibular → Columella becomes Stapes
smallest Bone

primary curves : present since childhood.

- Stapes is the smallest Bone.
- Presence of 7 cervical vertebrae : characteristics of mammals.

☆ Malleus — modified from articulate bone

☆ Incus — modified from quadrate bone

Vertebral Column

Vertebrae — 26 in adults
33 in children

4 curves in Vertebral Column

Cervical - secondary
Thoracic - primary
Lumbar - secondary
Pelvic — primary

} ☆ curvature in vertebral column makes bipedal motion possible.

Vertebra formula

for children $C_7 T_{12} L_5 S_5 Co_4 = 33$

In adults $C_7 T_{12} L_5 S_{(5)} Co_{(4)} = 26$

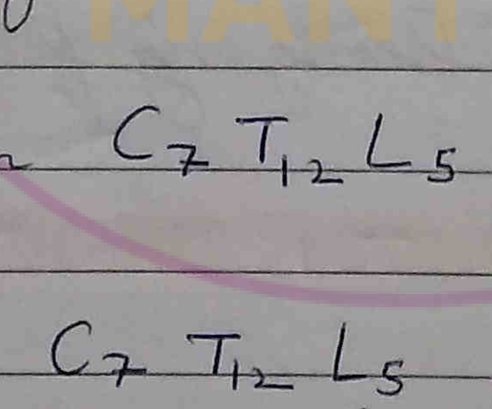
($S_{(5)}$ fuse, $Co_{(4)}$ fuse.)

Sacrum Coccyx

movable — Immovable

- Vertebra

Total of 7 processes

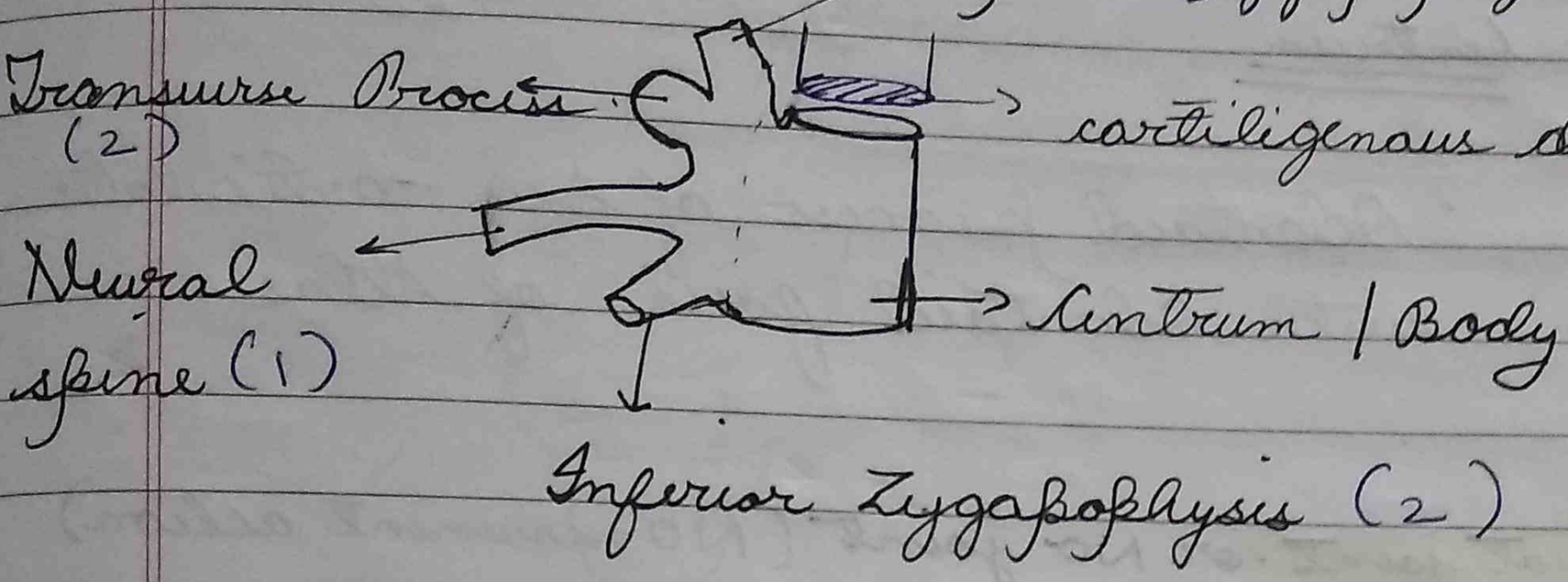


→ Neural spine / Spinous process (1)
→ Superior Zygapophysis (2)
→ Neural Canal
→ Transverse processes (2)
→ Centrum / Body (from notochord)

Front view

- Amphiplatyan → centrum flat from both sides.
  ↳ characteristics of mammals.

Lateral View

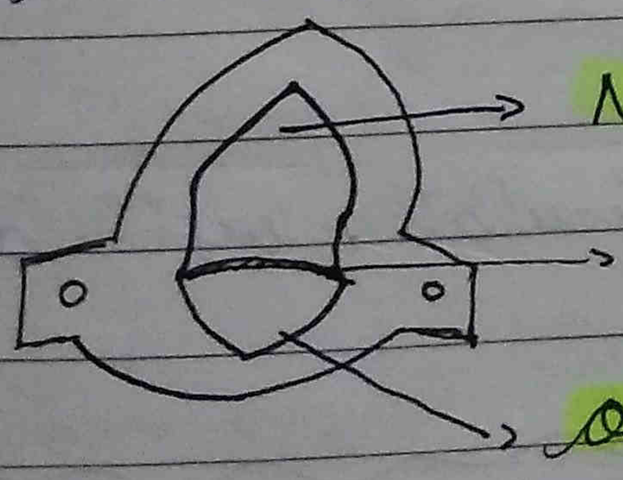


- Cervical Vertebrae (7)
  3rd — 6th are called typical cervical vertebrae.

M - Bifid spinous process.

I. Vertebrarterial Canal / Transversarium → Aperture in transverse process through which blood vessels pass to supply blood to brain and spinal cord.

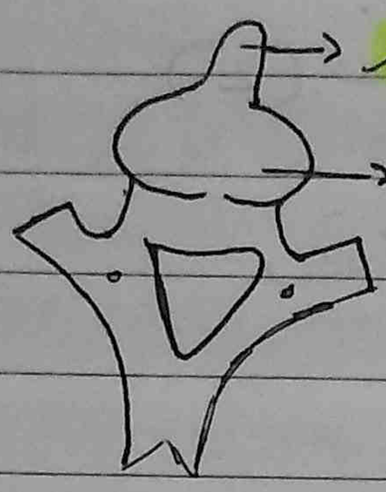
- 1st Cervical — ATLAS
  - Ring shaped bone
  - No centrum or spinous process.
  - 2 facets for articulation with occipital condyles.



of atlas articulates with second cervical vertebrae (Axis)

☆ Thoracic vertebrae are identified by the presence of costal demifacetes on centrum.

2 2nd Cervical - AXIS



• Odontoid process of Axis - articulates with Odontoid fossa of Atlas.

A → Pivot joint. or NO joint (NO movement action)

• 7th Cervical — Vertebra Prominens (largest)
- Spinal process is not bifid but ends in tubercle. → R
- Transversarium is absent.

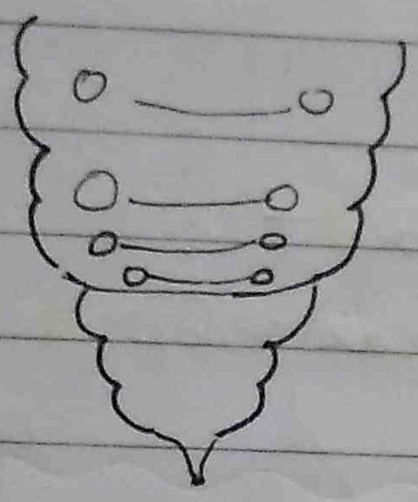
• Thoracic Vertebrae (12)
- Typical 2nd to 8th
- Atypical 1st, 9th, 10th, 11th, 12th

- 1 pair facets are also present to articulate with ribs.

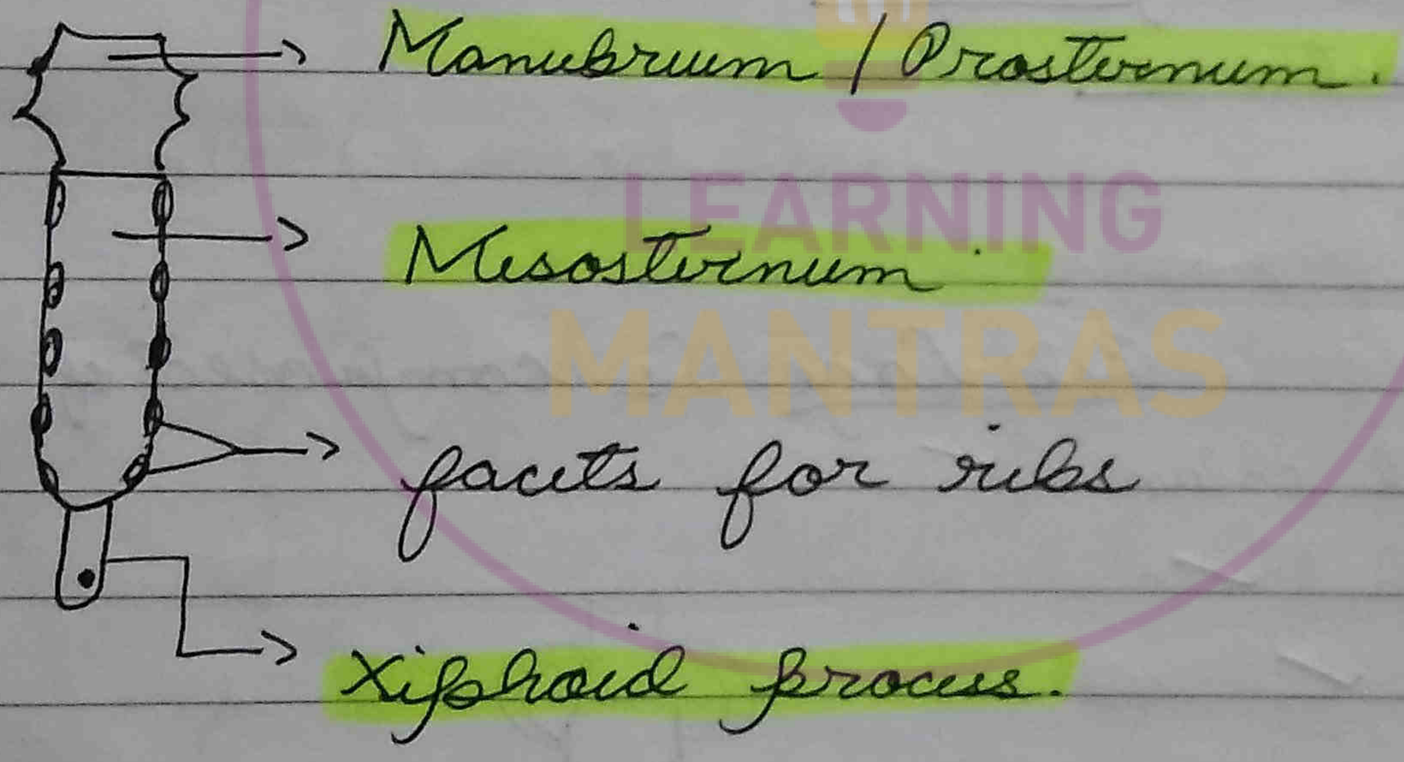
• Lumbar Vertebrae (5)
- Largest mammalian vertebrae.
- Large and heavy centrum
- Process are short.

- Coccyx form tail in other animals but it is vestigeal in humans.
- Ribs are called Bicephalic because it has two articulate facets.

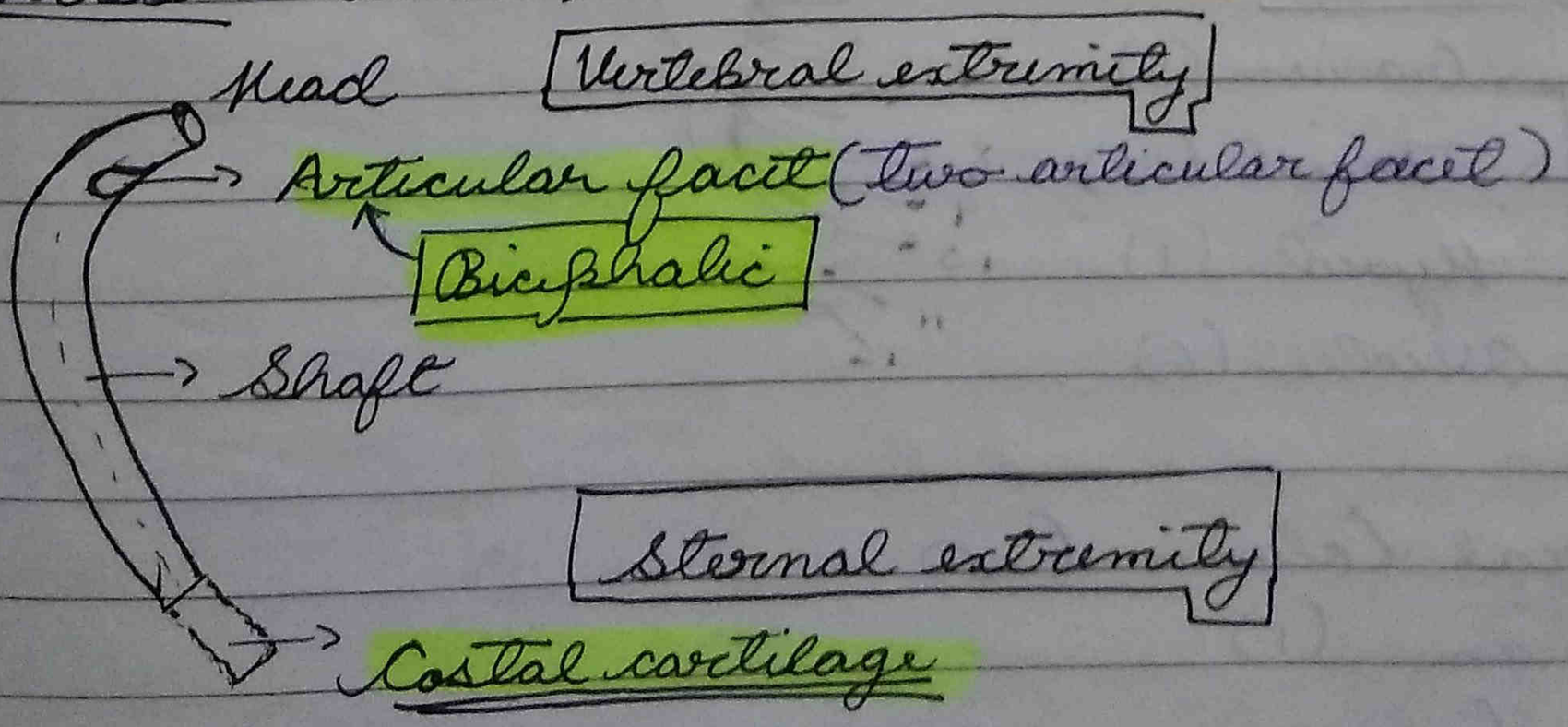
- Sacrum → formed by fusion of 5 sacral vertebrae
- Coccyx → formed by fusion of 4 coccygeal vertebrae



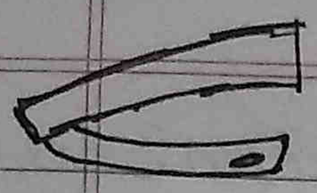
- Sternum (Breast bone)
  - Dagger shaped bone. (Single Bone)



- Ribs (12×2)



- Gorilla rib: 13th pair of rib.

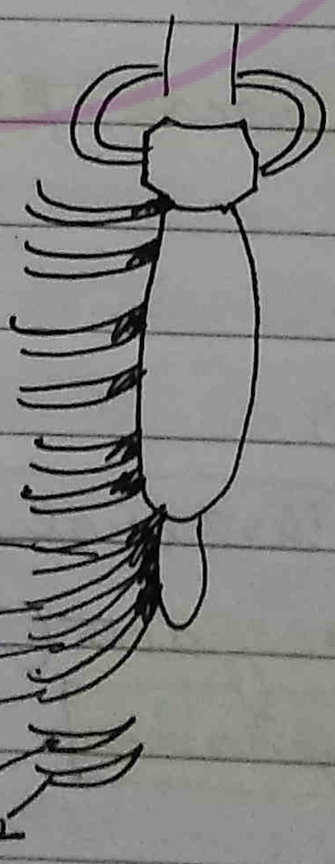


Ribs

- True ribs
  - Vertebro-sternal ribs
    - 1st to 7th
    - 1st rib → articulates with Manubrium
    - 2nd to 6th → articulates with Mesosternum
    - 7th → articulates partially with mesosternum and Xiphoid
  - Vertebro-Chondral ribs
    - 8, 9, 10
    - Articulate with costal cartilage of 7th
- False ribs
  - 11, 12
  - Floating ribs
    - Sternal extremities are free.

Rib Cage is composed of

- Vertebral column ✓
- Sternum ✓
- Ribs ✓



- Axial Skeleton (80)
  - Skull
    - Cranium (8)
    - Facial (14)
    - Hyoid (1)
  - Ear Ossicles (6)

Vertebral Column (26)
Sternum (1)
Ribs (24)

• Skin present between second and seventh rib.

Appendicular Skeleton (126)

- Girdles
- Limbs

Pectoral Girdle	Pelvic Girdle	Forelimbs	Hind limbs
↓	↓	↓	↓
Scapula (2)	Coxa (2)	30×2 = 60	30×2 = 60
Clavicle (2)			

• Pectoral Girdle

– Scapula (1 single Bone)

☆ Coracoid process

– flat, triangular bone.

– Clavicle (collar bone)

Articulates with Acromion process of scapula

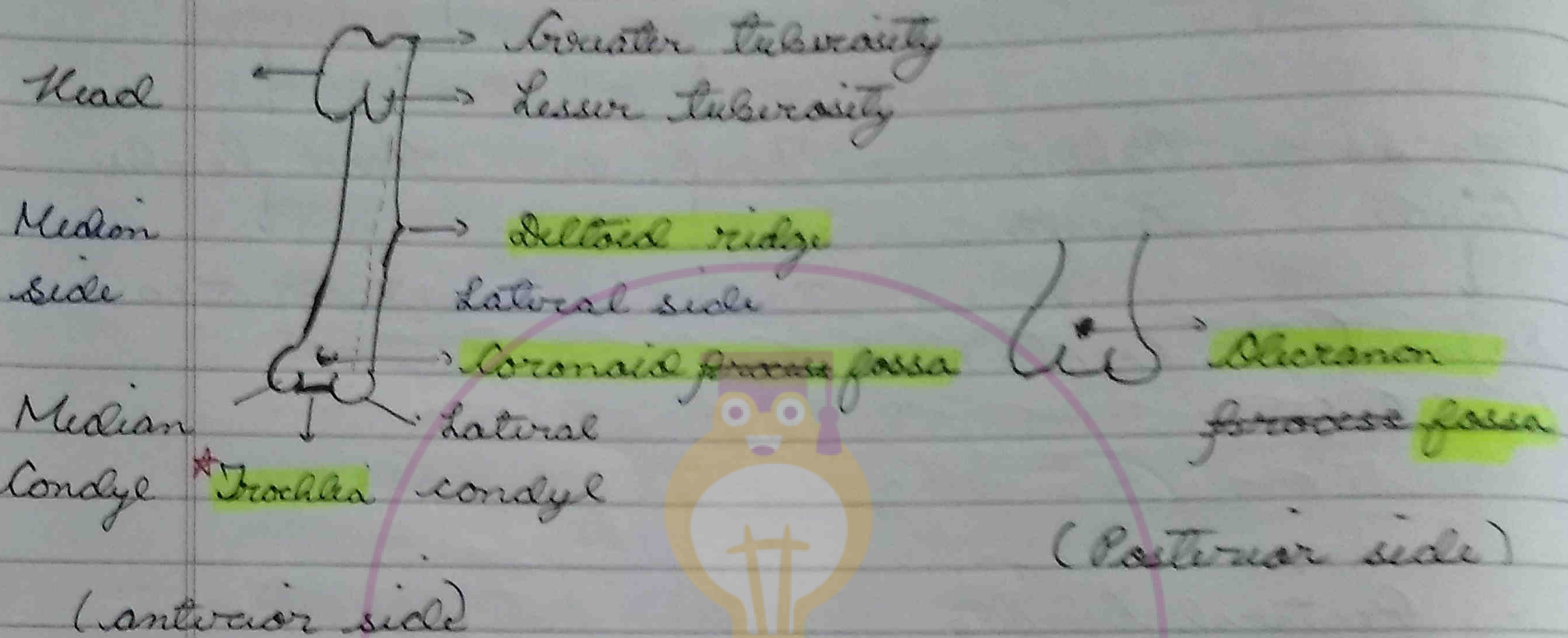
Articulates with Manubrium of Sternum above the first rib.

- At Deltoid ridge deltoideus muscle is attached.
- Ulna is longer than radius and is located on medial side of thumb. 1° Trochlea articulates with radius and ulna

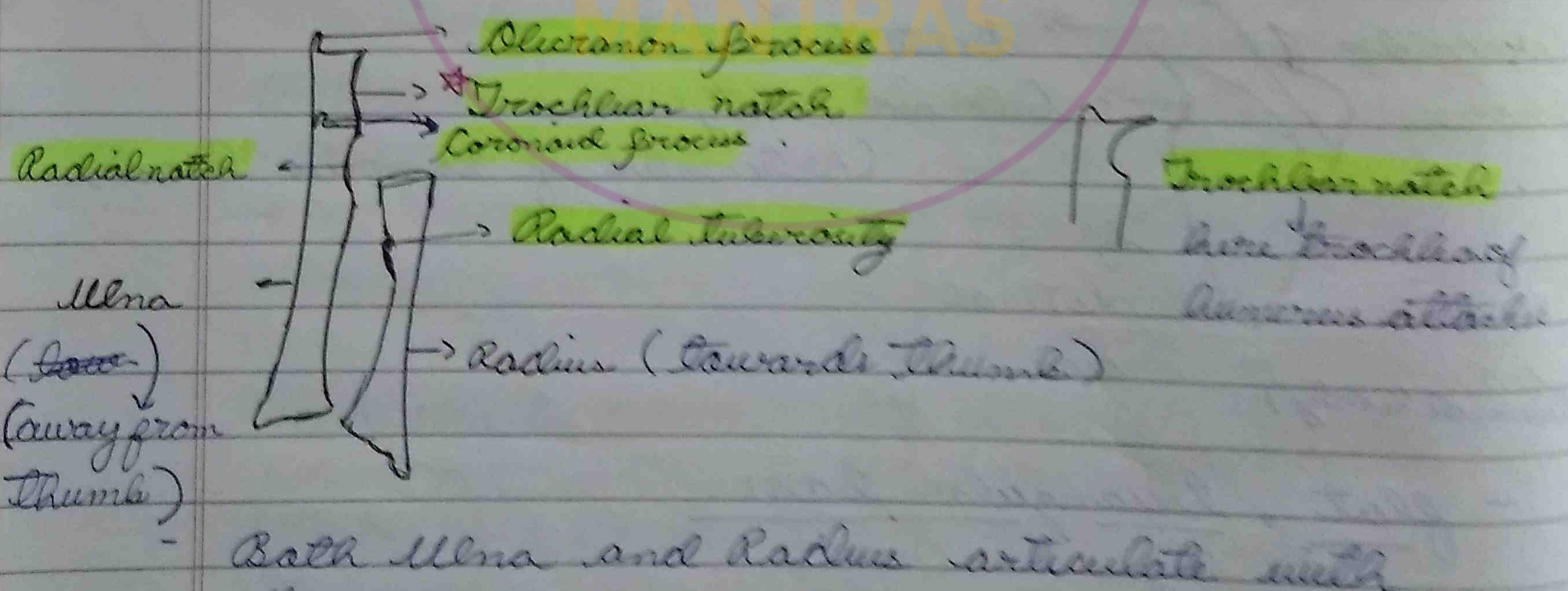
classmate

Forelimb

Humerus — upper arm
(funny bone)



Fore arm : Radius and Ulna



- Both Ulna and Radius articulate with Humerus.
during
* Flexion - coronoid process articulates into coronoid fossa.
- during extension - Olecranon process articulates

Proximal : Towards Body Distal : away from Body

into olecranon fossa.

- Wrist (Carpus)
  8 bones together called carpals

- arranged in 2 rows of 4 each

Thumb

- Proximal row
  - Scaphoid
  - Lunate
  - Triquetrum
  - Pisiform

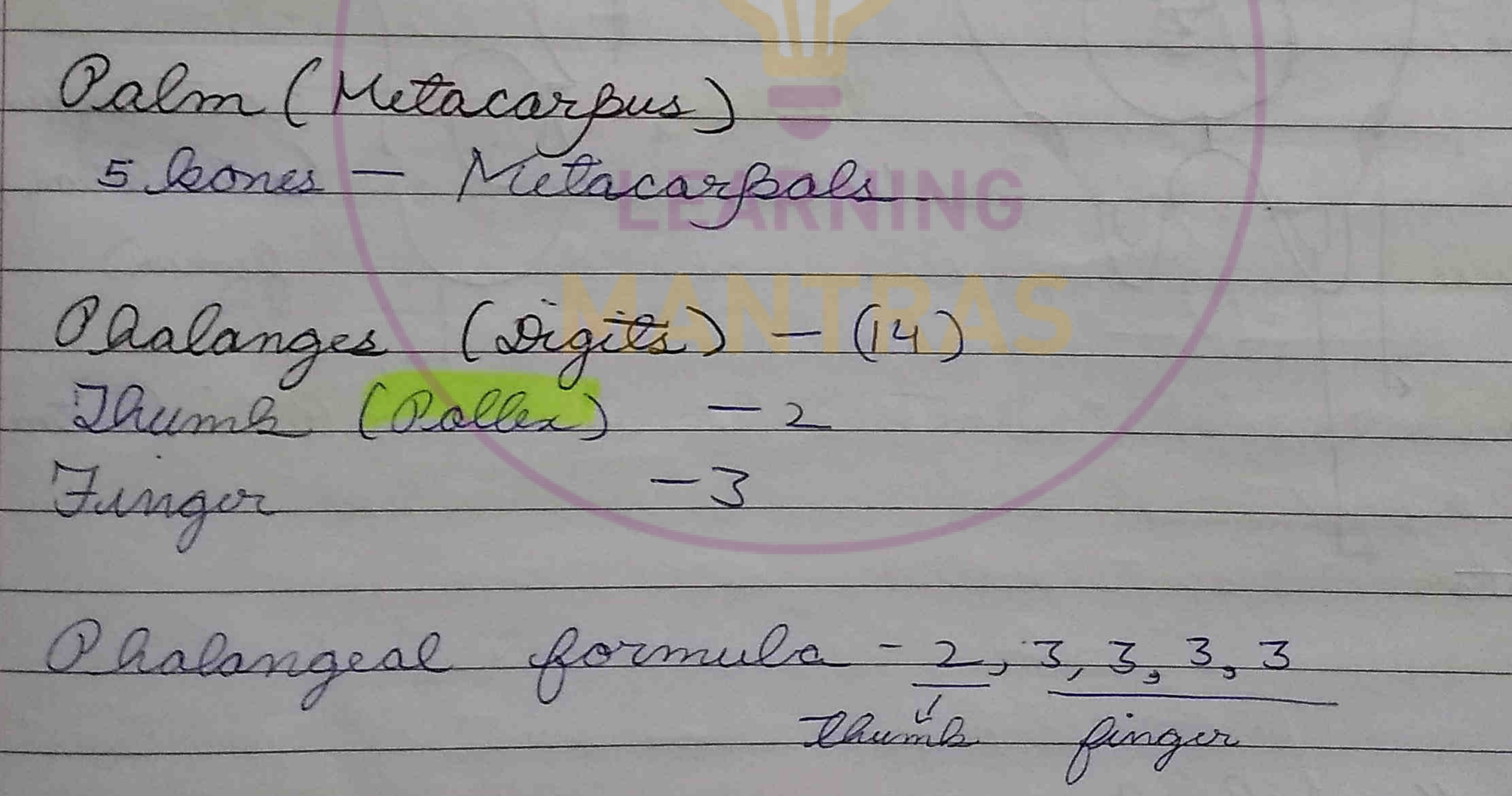
- Distal row
  - Trapezium
  - Trapezoid
  - Capitate
  - Hamate

outwards

- Palm (Metacarpus)
  5 bones — Metacarpals

- Phalanges (Digits) — (14)
  Thumb (Pollex) — 2
  Finger — 3

Phalangeal formula - $\frac{2}{\text{Thumb}}, \frac{3, 3, 3, 3}{\text{finger}}$

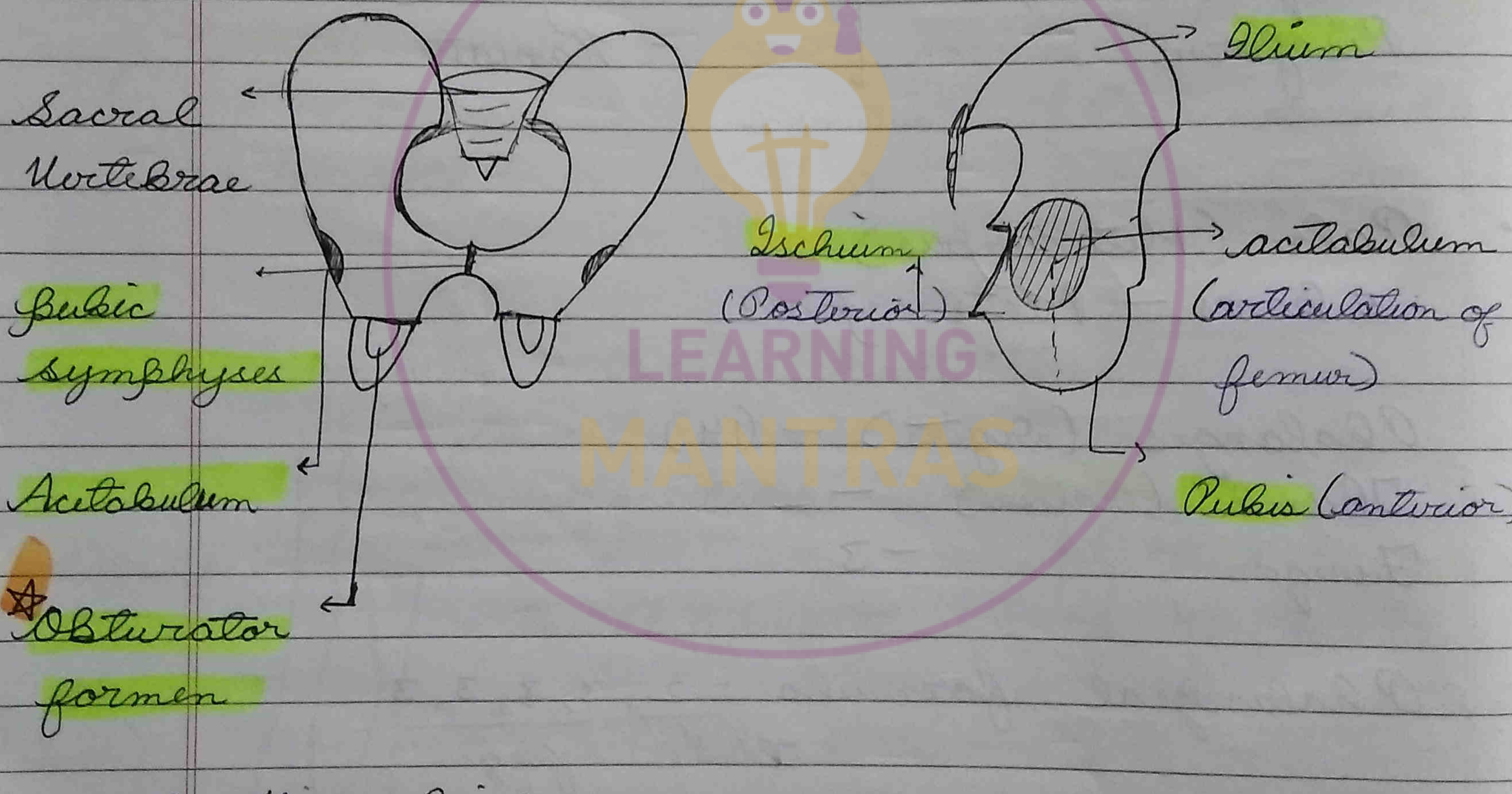


☆ Ilium articulates with sacral vertebrae and
☆ Obturator foramen is present b/w Pubis and Ischium.

Lower Extremities

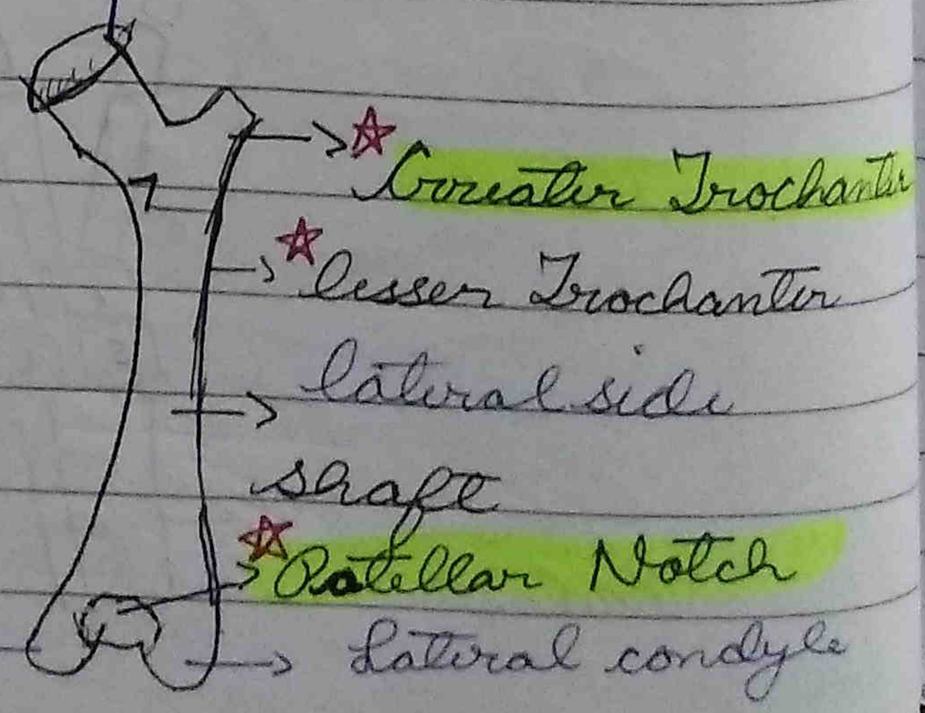
- Pelvic Girdle :
  Each half of pelvic girdle is made up of
  1 Coxa also called (Innominate bone).

- Each coxa is made by fusion of 3 bones —
  Ilium
  Ischium
  Pubis.



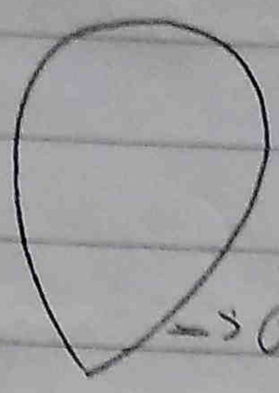
→ Hind limbs

- Femur : Thigh bone
  Longest bone of body.

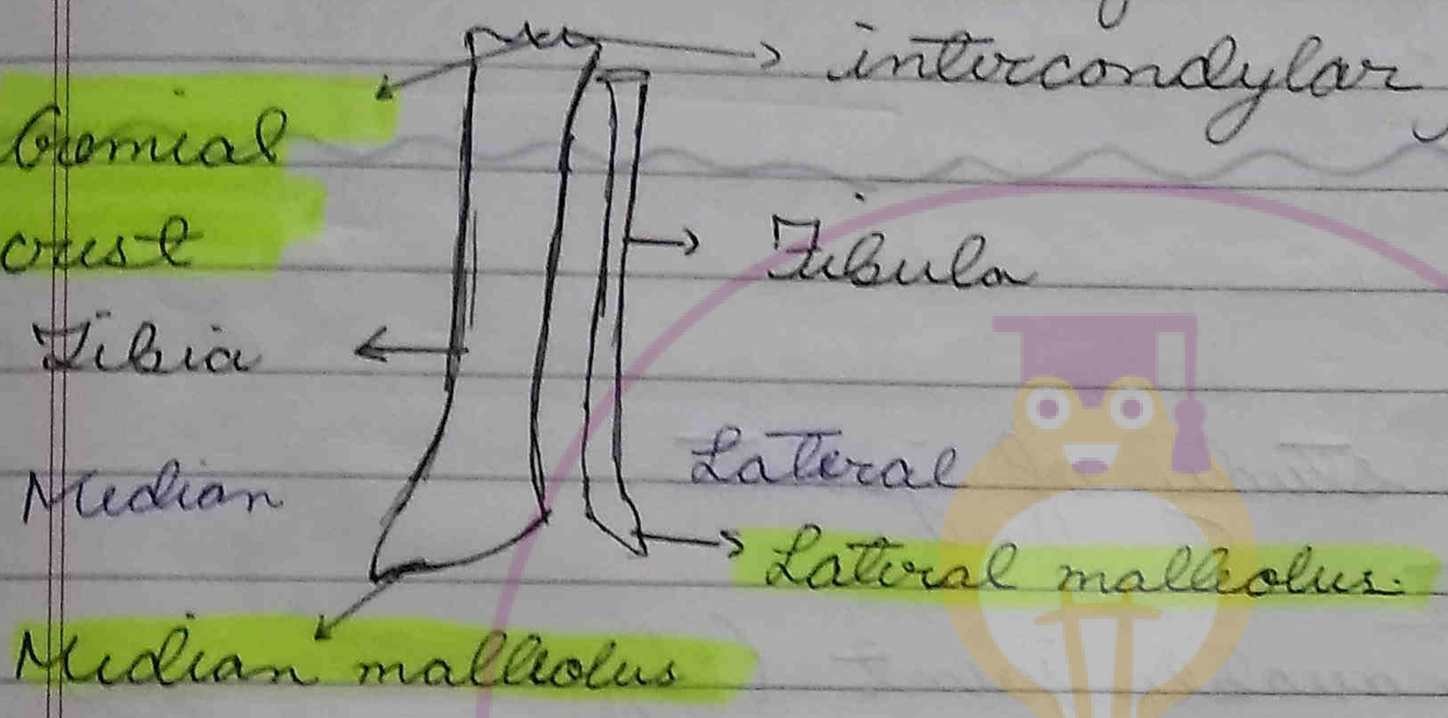


- Patella :
  Knee cap
  sesmoid bone

- Sesmoid bone → ossification of tendons.



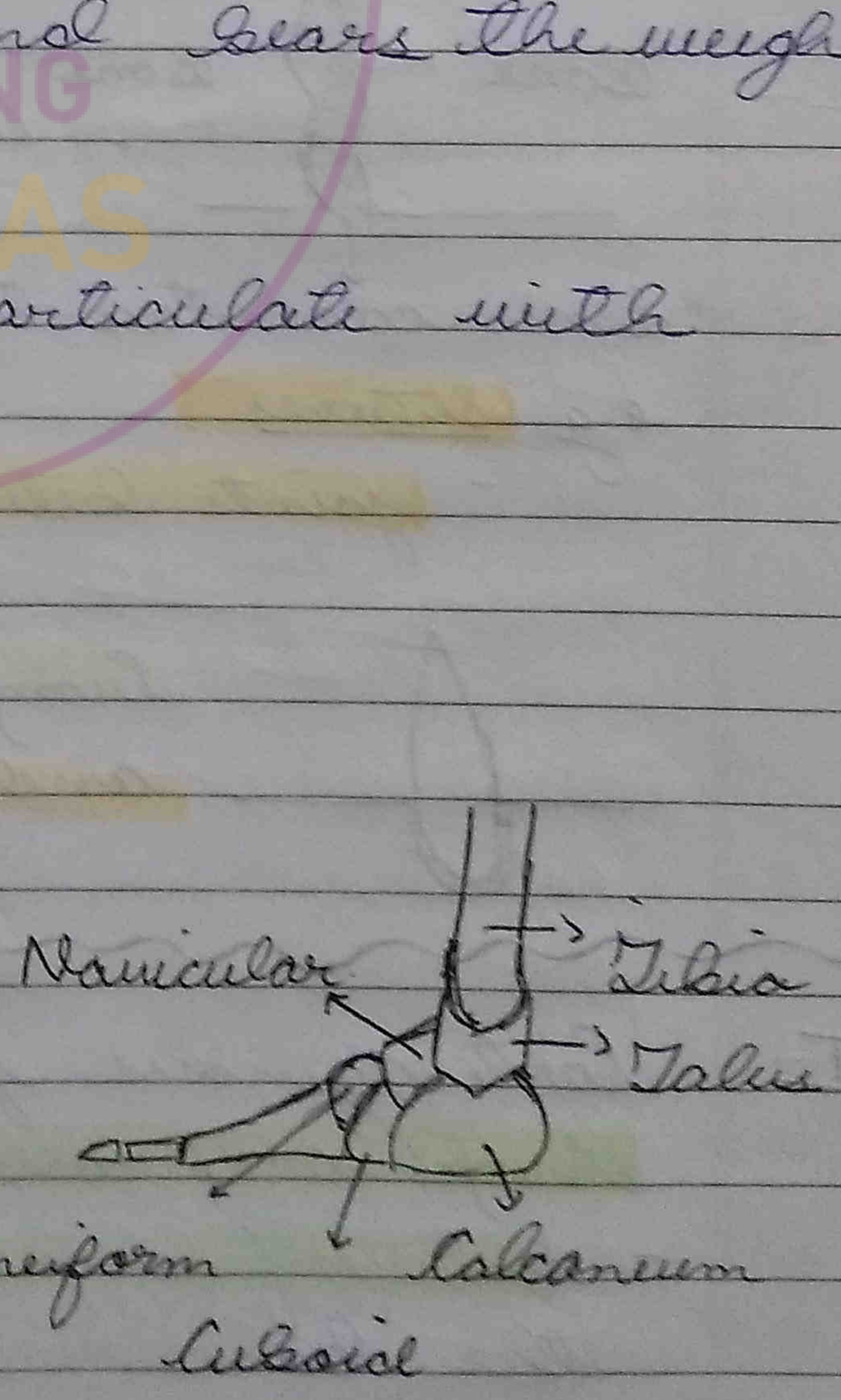
- Shank : Tibia and fibula



Tibia - strongest bone and bears the weight of the body

- Tibia and fibula - both articulate with Talus (1st tarsal)

- Tarsus : 7 tarsals
  Talus
  ✱ Calcaneum - heel bone
  Navicular —
  Cuboid
  3rd Cuneiform
  2nd Cuneiform
  1st Cuneiform.



Nucleus pulposus → embryonic tissue left in intervertebral disc.
Pollex is opposable but Hallux is not opposable.

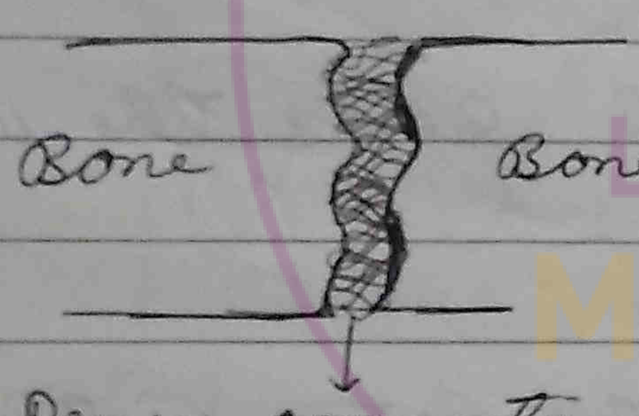
Metatarsus – (sole)
5 Metatarsals

Phalanges (Toes)
Great toe (Hallux) – 2
Toes – 3
Phalangeal formula : 2, 3, 3, 3, 3

Joints

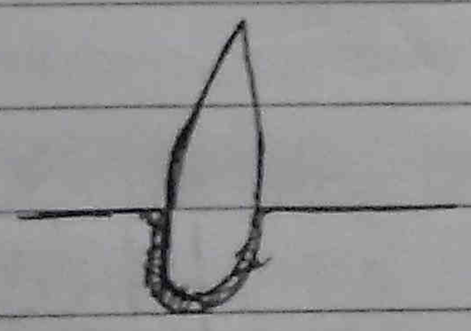
☆ **Arthrology**: study of joints

I Fixed / Immovable joint (Synarthroses)



Dense connective tissue (Collagen fibres)

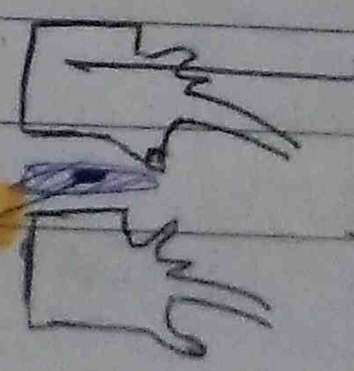
e.g **Sutures**
- joints between skull bones



Gomphoses — joint between teeth and sockets (present in jaw bone).

II Cartilaginous joints / Slightly movable / Amphiarthroses.
- White fibro-cartilage is present between the bones.

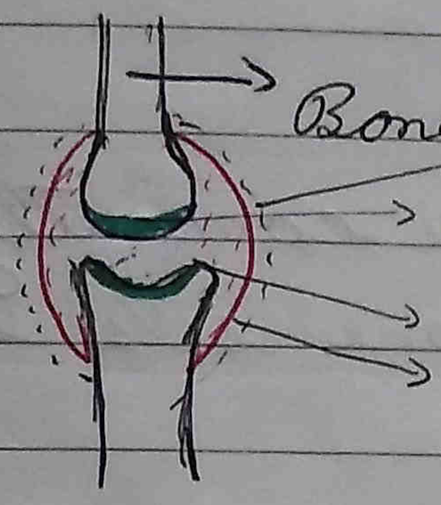
e.g **Intervertebral disc**
b/w Body of two vertebrae
nucleus pulposus



. Maximum joints in the body are gliding joint.

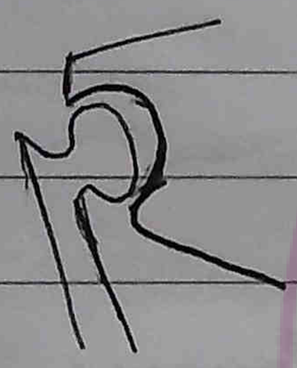
e.g ☆ Pubic symphyses → joint between two pubic bones

III Synovial joints / Freely movable.



Bone → Fibrous capsule
→ Articular cartilage (Hyaline)
Synovial fluid.
Synovial membrane.

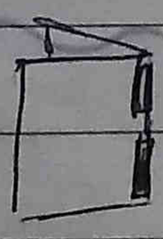
a) Ball and Socket joint



e.g Joint b/w humerus and glenoid cavity of scapula

- between femur and acetabulum of coxa.

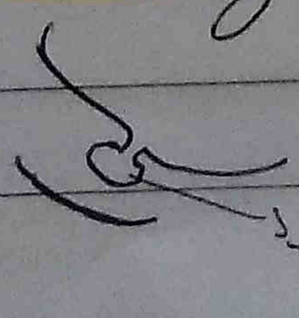
b) Hinge joint - allows movement in one plane only.



e.g Elbow joint
Knee joint
☆ Interphalangeal joint.

c) Gliding joint -
One bone slides over the other.
e.g ☆ Between zygapophyses of vertebrae.
Between carpals
Between tarsals.

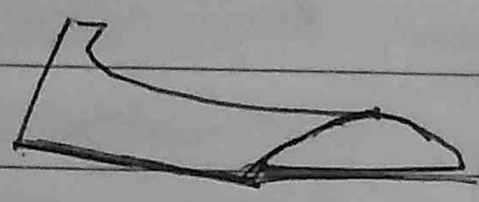
d) Ellipsoid / Condyloid joint



→ condyle.

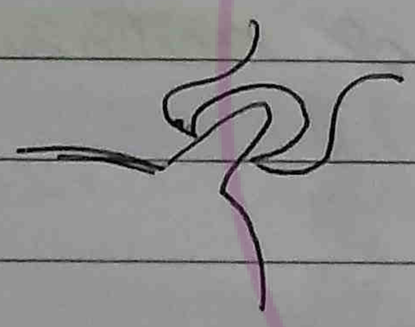
Condyle of one bone articulates in elliptical concavity of other.
e.g Atlas and occipital.
Metacarpal and phalanges.

e) Saddle joint



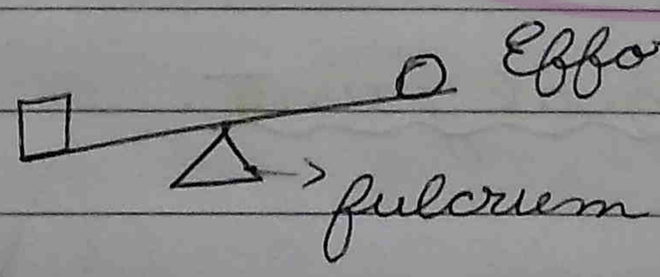
Saddle like concavity and other bone sits like a rider.
e.g Carpal and Metacarpal of Thumb.

f) Pivot joint



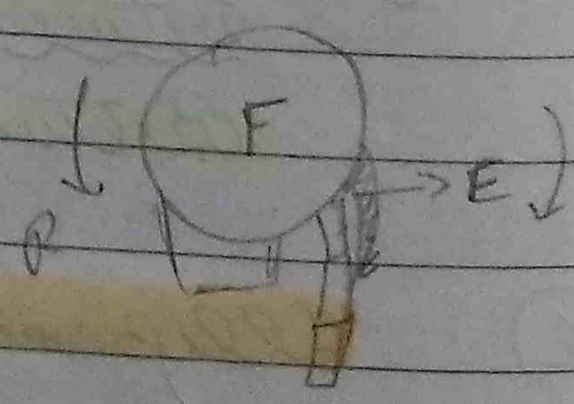
Bone has peg-like process while other bone has a ring.
e.g Atlas and Axis.
→ Radius and Ulna.

- Lever



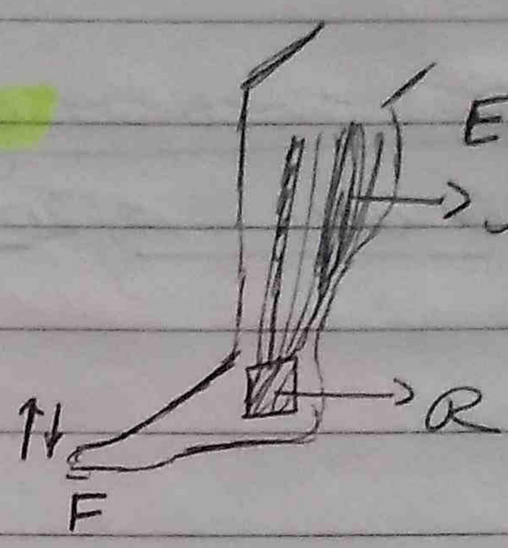
Resistance
(load)

- Class 1 Lever —
Fulcrum is in the middle
e.g Nodding of head.

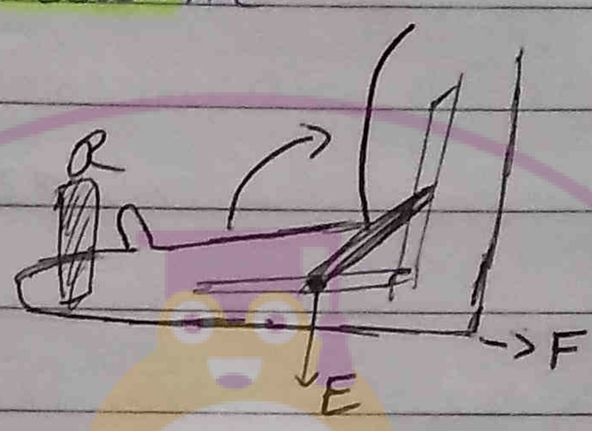


class 3 lever consumes maximum energy.

- Class 2 Lever
  Resistance in middle
  e.g Standing on toes



- Class 3 Lever
  Effort in middle
  e.g Flexion of forearm



- Disorders

- Arthritis → inflammation of joints

a) Gouty arthritis : due to accumulation of uric acid.

b) Osteo arthritis : age-related wear and tear as Articular cartilage wears off and synovial fluid decreases.

c) Rheumatoid Arthritis : autoimmune antibodies against streptococcal toxin attack synovial membrane.

- Osteoporosis : Bones are easily fractured.
  - Excess removal of calcium matrix by

★ estrogen decreases osteoclast activity.

parathyroid hormone.

- Due to absence of estrogen females develop osteoporosis after menopause