

Subject – Biology

Class- 12

Topic – locomotion and movement in human

30 July 2020

## Movement and Locomotion in Man

Notes :->

### \* Types of Movement

1. Amoeboid - Pseudopodia
2. Ciliary - Paramecium
3. Muscular - Human

⇒ Muscle

→ Mesodermal 40-50% of our body weight

⇒ Properties

1. Excitability (respond to stimuli)
2. Contractility (generate force)
3. Extensibility (stretched)
4. Elasticity (return to original state)

### ⊗ Types based on location

i) Skeletal muscle

→ Striped muscle

→ Striated muscle

→ Voluntary control

→ Locomotory action

→ Changes of body posture

ii) Visceral muscle

- Involuntary muscle
- Striation absent
- Smooth appearance
- Smooth muscle (non-striated)
- Inner wall of hollow visceral organs.
- Alimentary canal, reproductive tract.
- Transportation of food through digestive tract.
- Crameter in genital tract.

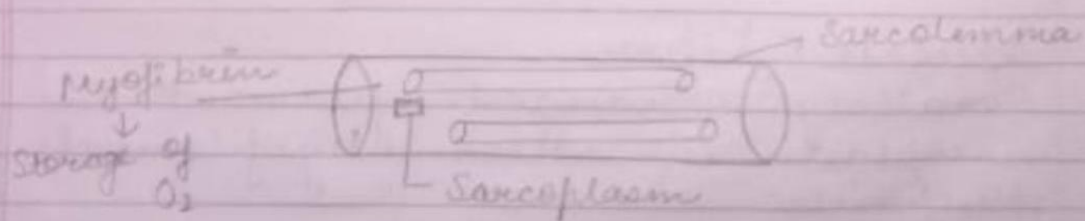
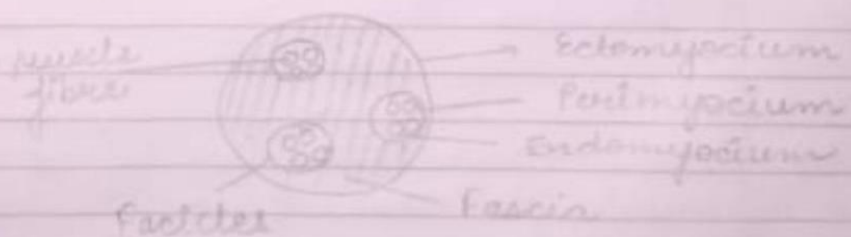
### iii) Cardiac Muscle

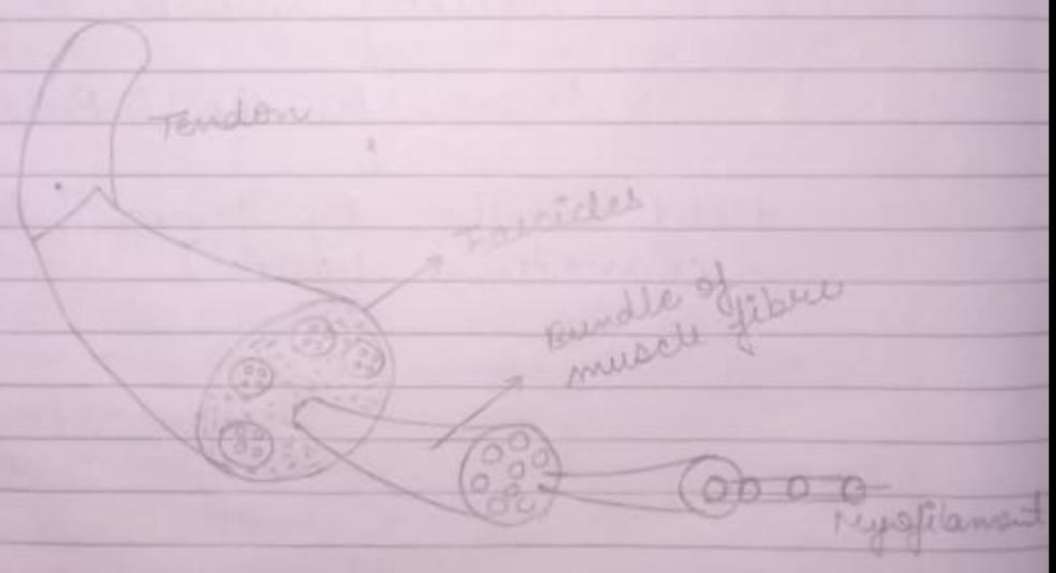
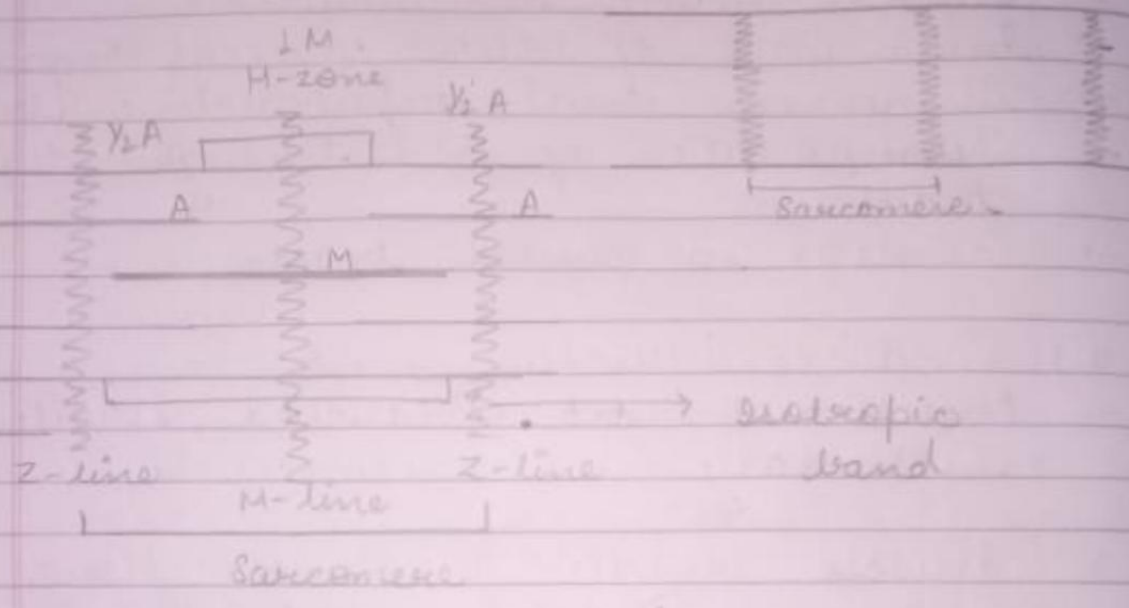
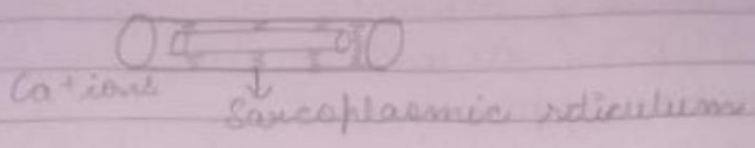
- Muscles of heart. Branched, Striated, involuntary.

\* Muscle bundle of Muscle fibre  
Skeletal muscle

↓  
Muscle bundles / Fascicles  
↓

Held together by fascia (Collagenous connective tissue)





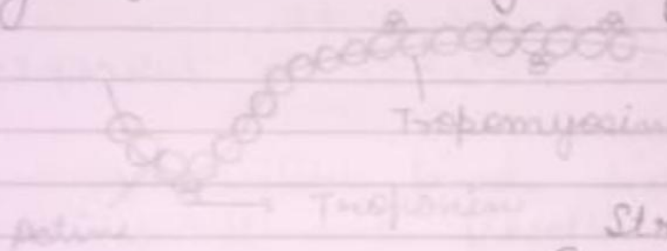
\* **Muscle Fiber**  
 → Parallely arranged filament in sarcoplasm is called Myofibrils or Myofibers.

Myofibrils → Dark & Light band

## Myofibrils

- |                 |                  |
|-----------------|------------------|
| Actin ↓         | Myosin ↓         |
| → Light band    | → Dark band      |
| → I-band        | → A-band         |
| → Thin filament | → Thick filament |

## \* Sliding Filament Theory



## Structure of Contractile protein

- Two F-actin bind with.
- F actin form by G protein.

## Tropomyosin

- Two filament of tropomyosin runs through close to F actin through out its length.

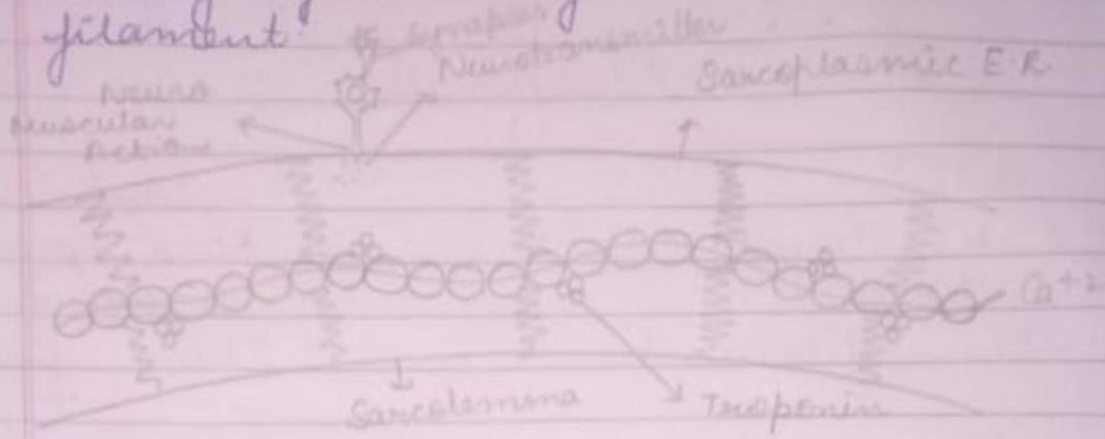
## Troponin

- At regular interval on tropomyosin.
- Mask active binding sites of Myosin on actin filament.

## \* Mechanism of muscle contraction action

1. Sliding filament theory.
2. Contraction of muscle fibre.

→ Sliding of thin filaments over thick filament.



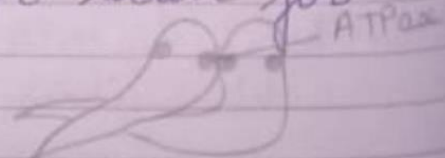
→ Signal transfer to neurotransmitter  
 $Ca^{+2}$  ion release to Sarcoplasmic Reticulum.

→  $Ca^{+2}$  ions bind with troponin. Troponin in turn itself and turns occur in tropomyosin then binding site of Myosin on actin has exposed to attached & formed cross bridge.

### Structure of Myosin



⇒ Myosin attached with actin for contraction



→ ATPase work on ATP  
 site of ATP break into ADP +  $P_i$ .

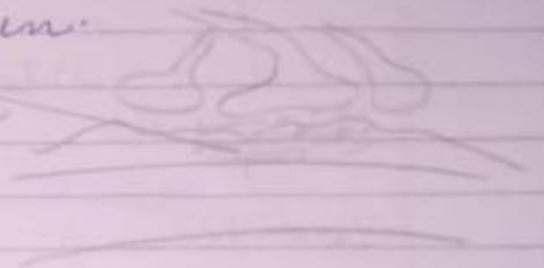
→ This energy use in jumping of myosin to attached with Actin by power.

stroke.

- Next ATP again bind with ATP site which is blank because of last ATPase activity.
- This cycle continue again.

→ Motor Neuron + Muscle fibre = Motor unit

Neuro-transmitter



→ Motor Neuron muscular junction

↓ b/w

Motor neuron & sarcolemma

→ Neurosignal

↓

Neuromuscular Junction

↓

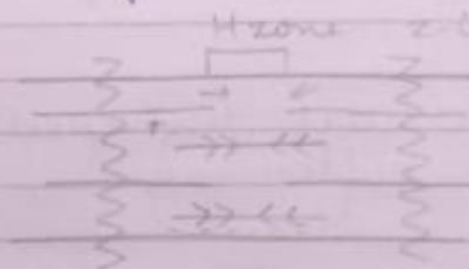
Neurotransmitter (Acetylcholine) release

↓

Generates Action Potential in sarcolemma

↓

Release of  $Ca^{2+}$  into sarcoplasm



H-zone & Z-line contract

Cross Bridge

↓

Pulls attached actin filaments towards 'A' band

↓

Z-line attached to actin is pulled inwards

↓

Shortening of sarcomere

↓

Contraction

↳

I-band get reduced

↳ A-band retains length

Myosin

- Release ADP + P
- Go back to release state when new ATP bind with ATP site.
- New ATP bind and a cross bridge broken.
- ATP again hydrolysed by myosin.

\* Relaxation

- Till  $Ca^{2+}$  ions are pumped back to Sarcoplasmic cisternae.

↓

Making of actin filament

↓

Return of Z line back to normal position

↓  
Relaxation

Reaction time of muscle may vary

↓  
Anaerobic respiration in muscle.

↓  
Lactic acid accumulation

↓  
Breakdown of Glycogen

Red Fibre	White Fibre
→ Myoglobin	→ Less pigment
→ O <sub>2</sub> storing pigment	→ Whitish appearance
→ Reddish appearance	→ Few mitochondria
→ AKA anaerobic muscle	→ anaerobic fast-
→ Plenty of mitochondria	→ Mitochondria are less in number
→ Lower	
→ High ATPase activity	→ Higher ATPase activity
→ High capacity for aerobic metabolism.	→ High capacity for anaerobic metabolism glycolysis.



Notes :->

## Skeletal System

Specialised connective tissue (Matrix/  
fibre / cell)

Bones

→ Hard matrix made of  
→ Ca<sup>+</sup> salts

Cartilage

→ Pliable matrix  
→ Chondroitin salts

## Types of Skeletal System

Axial Skeleton

1. Skull
2. Vertebral Column
3. Sternum
4. Ribs (12 pair)

Appendicular Skeleton

1. Limb Bones
2. Girdles

A. Axial Bones

i) Skull

→ Cranial bones :- 8 in number covering the brain

2. Facial bones :- 14 in number.

Nose to ear → Sphenoid bone  
 On the nose → ethmoid bone

3. Hyoid bone :-  
 → Forms Ear ossicles → Malleus  
 → Incus  
 → Stapes

→ U-shaped.

→ Tongue attached with Hyoid bone

→ Dicondylic - Skull attached with two hook like structure with vertebral <sup>stiles</sup>

ii) Vertebral Column  
 Cervical 7  
 Thoracic 12  
 Lumbar 5  
 Sacral 1 Fused (5 bones)  
 Coccygeal 1 Fused (4 bones)



→ 26 Vertebrae serially arranged. → Dorsal.

→ Neural Canal → Spinal cord  
 pass Sacrum

→ Atlas Ist → Articulates with occipital condyles

⇒ Functions -

→ Protect spinal cord

→ Supports head.

→ Point of attachment for ribs & musculature of back.

Vertebral Column

iii) Ribs :-

- 12 pairs (True flat bone)
- connected
  - Dorsally → Vertebral column
  - Ventrally → Sternum
- Bicephalic - Two articulation surface on its dorsal end
- 1st 7 pair pair of ribs (True ribs)
  - Dorsally → Thoracic vertebral
  - Ventrally → Sternum
  - True ribs → connected with the help of hyaline cartilage.
- ⇒ 8, 9, 10th ribs (False ribs) [Vertebral -  
↓  
Join with 7th ribs chondral]
- false ribs attached vertebrae not sternum.
- ⇒ 11th, 12th Floating ribs
  - Attached to vertebrae
  - not connected ventrally

Rib cage = Thoracic vertebral + Ribs + Sternum

B. Appendicular Skeleton

i) Limb Bones

Hand Bones (Fore limb)

\* Humerus



Radius (Thumb side bone)



Ulna



Carpels / Wrist (8 bones)

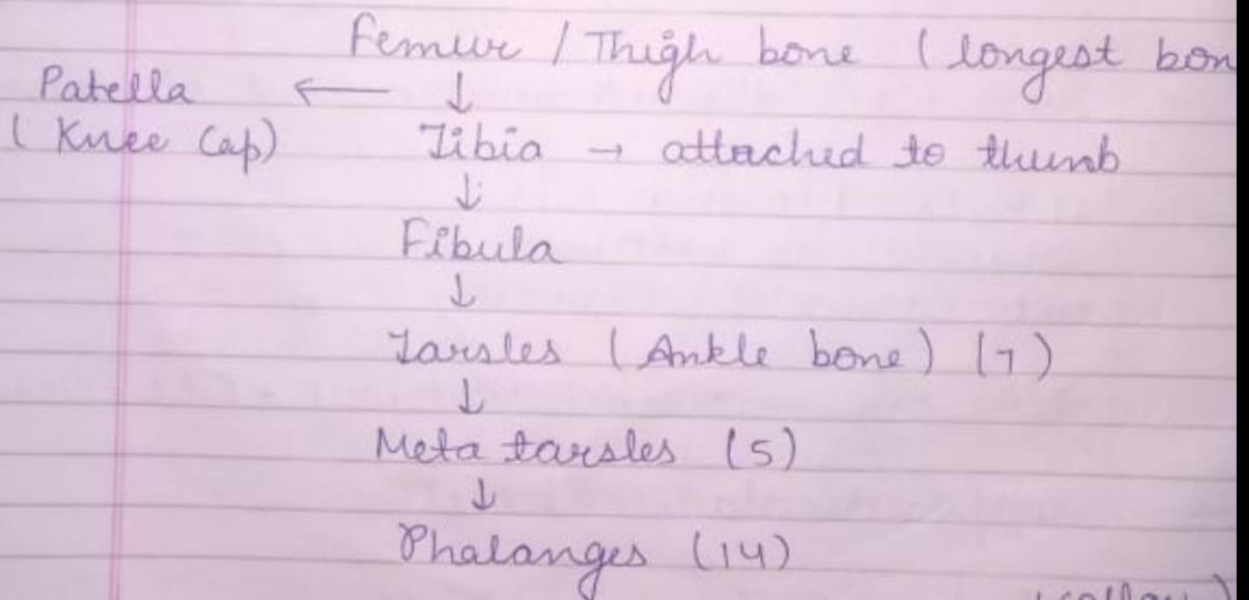


Metacarpals / Palm (5 bones)



Phalanges (14 bones) ⇒ Thumb (2)  
Fingers ( $3 \times 4 = 12$ )

Hand Limb Bones



ii) Girdles

1. Pectoral girdle is made of Scapula & Clavicle
2. Pelvic girdle is made of pelvic bone. It helps to attach lower limb to upper body

(collar bone)  
↑

★ Very Short Answers:→

1. Name the smallest structural and functional unit of muscles.  
Muscle Fibres
2. What joins the muscle to the bones?  
Tendons
3. What joins bones to other bones?  
Ligaments
4. The sacrum is composed of how many vertebrae?  
5 vertebrae.
5. How many bones constitute the skull?  
8 Cranium bones + 14 Facial bones + 1 + 6  
= ~~22~~ 29 Skull bones.
6. Name the important stored substance in bones.  
Calcium Bone Marrow

★ Short Answers:→

1. What are cartilagenous bones? Explain.  
Cartilagenous or replacing bones: At the initial stage of formation cartilage

PAGE NO. \_\_\_\_\_  
DATE: / /

Bones develop in the form of cartilage. In this stage these are soft. Their matrix is made up of condensation protein and in it chondrocytes are found & these are covered with perichondrium covering. Their structure changes along with the growth of animal. Due to deposition of calcium salts in the matrix, these become rigid and hard and in place of them osteocytes are formed. Osteocytes secrete ossein protein. Perichondrium converts into periosteum and cartilage is modified into bone.

2. Write the main functions of skeleton.  
Function of Skeleton :

1. The skeleton forms a rigid frame work gives & maintains the shape of body.
2. Protects the soft body organs like, brain, lungs, heart, spinal cord etc.
3. The skeleton furnishes a hard surface for the attachment of muscles.
4. Skeleton helps in movement.
5. Bone marrow produces blood corpuscles.

3. How is muscle stimulated for contraction.  
This is the process by which action potential induces muscle contraction. Action potential from muscular muscle cell quickly transmitted by T-tubules system in sarcoplasm. Due to this potential  $Ca^{2+}$  ions are released from muscle cytoplasmic

reticulum and get attached with troponin-C. As a result troponin of troponin present at the active site become free the transverse bridges of myosin filament get attached them process of contraction starts.

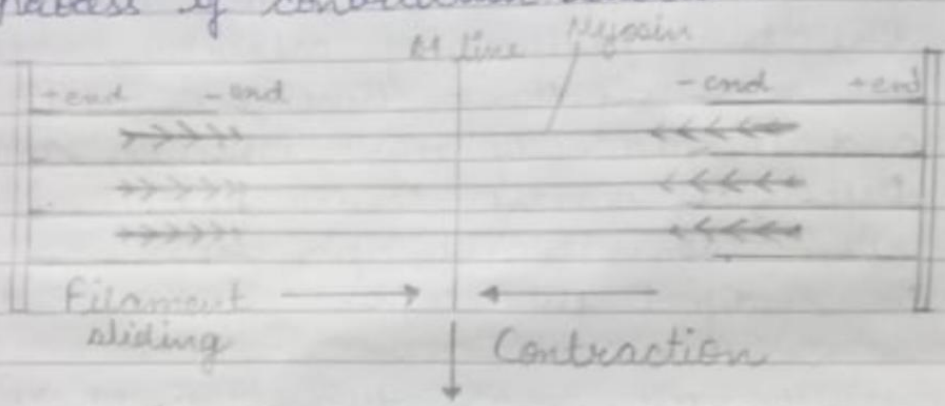
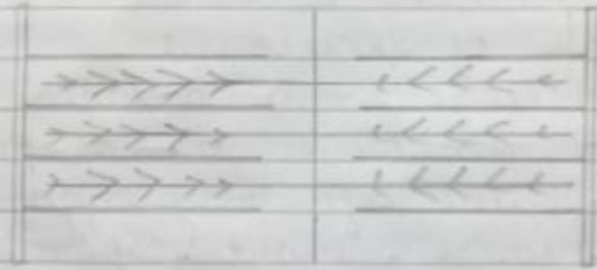


Fig:

Fibre  
Gliding  
Process



4. If all joints of the arm become immobile then what effect will it have?  
If all joints of the arm become immobile then our arm will not move in any direction.

5. What is called osteoporosis?  
Osteoporosis is the reduction in bone tissue mass causing weakness of skeletal strength. It is characterised by decreased bone mass i.e. matrix (organic part) and

minerals (calcium) both are decreased. Bone becomes thin, weak and less elastic and it breaks easily. Osteoporosis affects whole skeleton but girdles, wrist & vertebrae are highly affected. Osteoporosis is more common in women of old ages due to the deficiency of estrogen hormone; calcitonin parathyroid hormone and glucocorticoid hormones are other causes of this disease.

6. What is the energy source of muscle contraction?  
ATP
7. If the motor nerve innervating the skeletal muscle is cut then what effect will it have on the muscle?  
Stimulation will not pass to brain.

### \* Long Answer

1. Write the detailed structure of skeletal muscle.
- Skeletal muscles are attached to bones by tendons. Therefore these are called as skeletal muscles. Their muscle cell is long cylindrical and multinucleated. Myofibrils of skeletal muscles possess light and dark bands arranged alternatively. Hence these are known as striated muscles. Skeletal muscles



DATE: / /

work under the voluntary control. Thus these are also called voluntary muscles.

- i) Primary, or thick myofilaments: These are made up of myosine protein. Their diameter is about  $100\text{\AA}$ . They are present on A-band.
- ii) Secondary or thin myofilaments: They are composed of actin protein. Their diameter is about  $50\text{\AA}$ . They are from the Z-line upto the edge of the M-band.

Molecular Organisation of the Contractile System: Based on their role in the contractile junction of muscle tissue from there are three types proteins that are found in muscular tissue.

- i) Force generating proteins: (a) Myosin, (b) Actin
- ii) Regulatory proteins: (a) Troponin, (b) Tropomyosin
- iii) Structural proteins: (a)  $\alpha$ -Actinin, (b) M-Disc protein, (c) C-proteins.

- i) Myosin: It forms primary of thick myofilaments. It forms half part of all the protein in filament. Its molecular weight is 500,000. It is  $\alpha$ -coiled or helical protein.
- ii) Actin: Its molecular weight is 42000. Actin found in two state. Several units of globular actin G-actin form chain of F-actin. In myofilament it is found

in the two stranded form which are coiled with each other.

- iii) Tropomyosin - It has molecular weight of 64000. It is composed of long (about  $400\text{\AA}$ ) and two  $\alpha$ -helix units. Each tropomyosin molecule is associated with seven units of G-actin.
  - iv) Troponin: It is a protein associated with tropomyosin. It is made up of three components -
    - a) Troponin C: Calcium ions form bond with it
    - b) Troponin I: It acts as a inhibitor for bonding between myosin & F-actin.
    - c) Troponin T: It bound with tropomyosin.
  - v) C-protein: It is found in between myosin myofilament.
  - vi) M-line protein: M-line situated in the middle part of H-zone is formed from this protein. It anchors the myosin filaments in their respective positions.
3. Sarcotubular System: It composed of the following structures of found in sarcoplasm.
- i) T-system - This system contains transverse tubules. These tubules are directly related with sarcolemma.
  - ii) Sarcoplasmic Reticulum: Smooth endoplasmic reticulum modifies into sarcoplasmic reticulum around the each myofilament. It is composed of thin tubules and cisternae.
4. Sarcosome: The mitochondria of muscle.

cell are called sarcosomes. The size of them are larger in comparison with mitochondria present in other cells.

5. **Neuromuscular Junction:** This joint is a physiological communication between muscle and nerve fibre. The axons of nerve cells which innervate skeletal muscle are called motor neurons. These axons are myelinated, they divide into thin branches near myofibrils. Myelin sheath is absent around these skeletal branches. These branches are in contact with sarcolemma. But are not attached with sarcolemma. The ends of terminal branches of axon form a knob like structure which are known as synaptic knobs. Synaptic vesicles of these knobs are filled with a neurotransmitter, acetylcholine, ACh. Below the terminal axon, muscle cell after modification forms a motor end plate. Here the receptors of ACh are situated at sarcolemma.

2. What is joint? Describe the different types of joints present in human body?  
The structural arrangement of tissue which connect two or more bones together at their place of meeting is called a joint. Joints perform different functions and are of different types. Joints are grouped into three categories on the basis of movement.

1. Synarthrosis :- The joint which does not allow movement of is called immovable joint. In these joints bones are joined tightly by fibrous connective tissue. There is no space between the bones. For eg :-

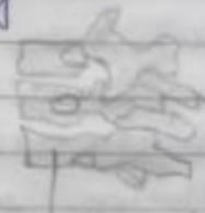
2. Amphiarthrosis :- It is a rigid joint but due to the tension limited movement is possible. In these joints the end of the bones connected with fibrous cartilage. These joints between bones are called symphysis. Pubic symphysis joints between centra of vertebrae, median symphysis are the examples of these types of joints.

⇒ Sub types of these are as follows:

### Types of Joints



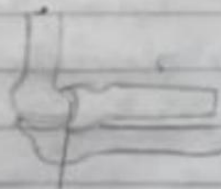
Ribs of Vertebral Column  
(Amphiarthrosis)



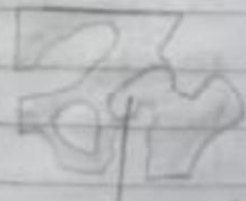
vertebral column  
(Cartilage joint)



Skull  
(Synarthrosis)



Elbow  
(Hinge Joint)



Hip joint  
(Ball and socket joint)

i) Pivot joint : A joint b/w atlas of axis vertebra. In these lateral movement is possible.

ii) Gliding joint : Joints of vertebrae, joints of wrists, joint of knee. These contain flat joint surface. These joint permit sliding movements of two bones over each other.

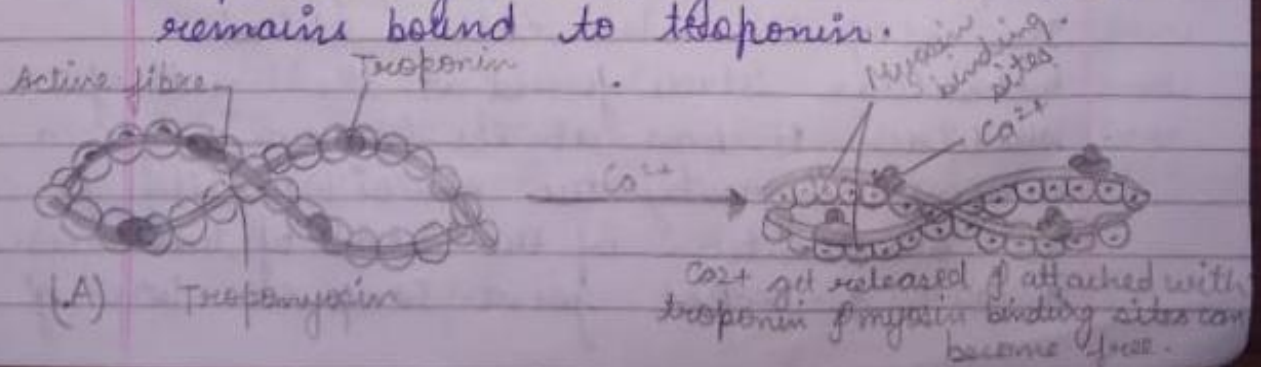
3. Synovial joints or Diarthrosis : The bones which are joined with this type of joint can move freely in one or more directions. Free spaces are present which are called as synovial cavities. Ligaments collectively forms a fibrous capsule is coated with synovial membrane. This membrane secretes synovial fluid containing mucin. Sub types of this joint are as follows :

- i) Ball & socket joint : shoulder & hip joints. In these movement in different directions is possible.
- ii) Hinge joint : Elbow joint, knee joint, joints of fingers, occipital condyle & atlas joint. In this joint movement is possible only in one direction.
- iii) Ellipsoidal joint : Joint b/w radius & carpus. Movement in two directions is possible.

3. Describe the mechanism of muscle contraction with diagram.

The contraction takes place by sliding process which starts along with the attachment of transverse bridges of

myosin and actin filament. The transverse bridges on the myosin head binds with a molecule of ATP just before binding the active site of actin filament. Due to the ATPase of myosin head cleavage of ATP into  $ADP + P_i$  take place. This  $ADP + P_i$  remains bound to the myosin head and provides energy for the movement of the myosin head. Just after myosin head gets attached to the active site actin filament. The conformation of head are changed due to bonding between this purpose energy obtained due to cleavage of ATP is used and sarcomere of actin filament pulls towards the actin filaments. For the due to the attachment of ATP the head becomes separate from actin. Again ATP cleavage take place and myosin head get attached with new active site and above process are repeating again. The actin filament slides due to the repeated activity of head of transverse bridge and contraction takes place. In the contraction many filaments and transverse bridges involve. This process is repeated again and again till  $Ca^{2+}$  ions remains bound to troponin.



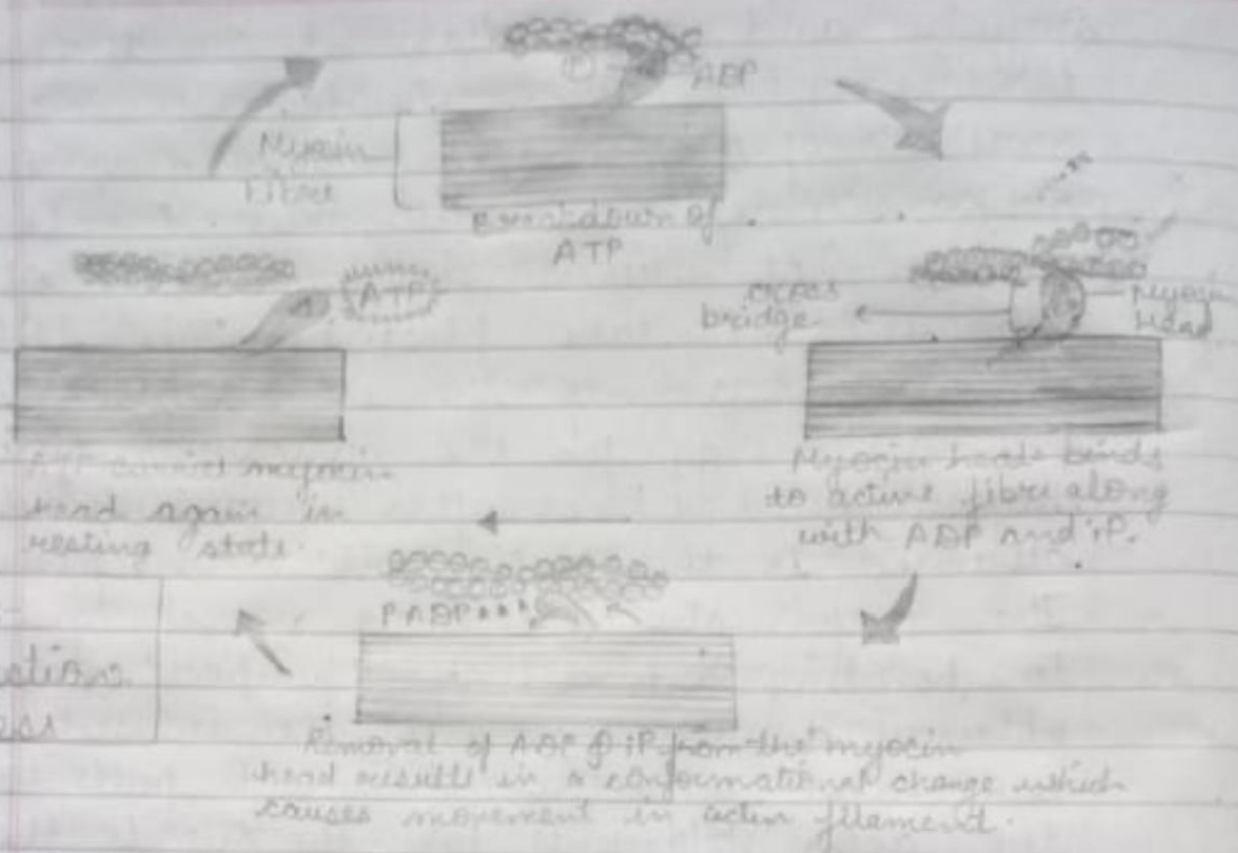


Fig:  
Contraction  
Process

4. Explain the structure and importance of the various girdles in human.
- Appendicular skeleton includes girdles of bones of fore and hind limbs.
- Pectoral Girdle:** Human pectoral girdle has two halves. Each half is known as os innominate. Both halves are separated from each other. Each half consists of two bones clavicle & scapula.
- Scapula is flat and triangular bone. The scapula also called blade (shoulder blade) found at the back of shoulder. It has at its lateral angle a shallow concavity the glenoid cavity for the articulation of the head of humerus. a ball & socket joint. Scapular bone of

the the present at the upper outer surface of scapula. The process of this spine are called acromian & coracoid.

Clavicle or collar bone is a well developed bone. It is thin, long & and curved bone. Its one end joints with acromian & another end joints with sternum.

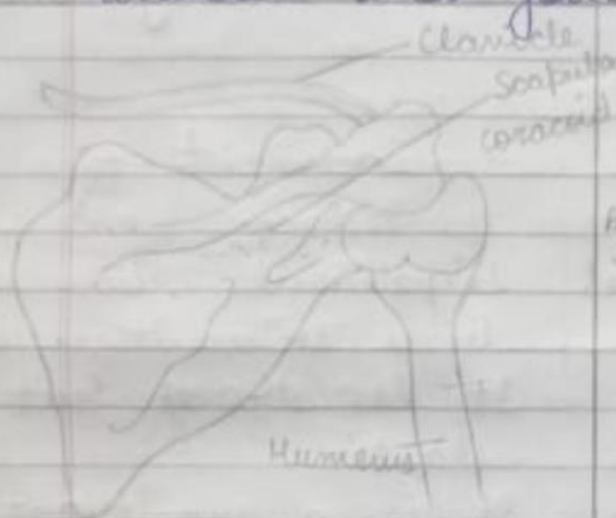


Fig:- Pectoral Girdle

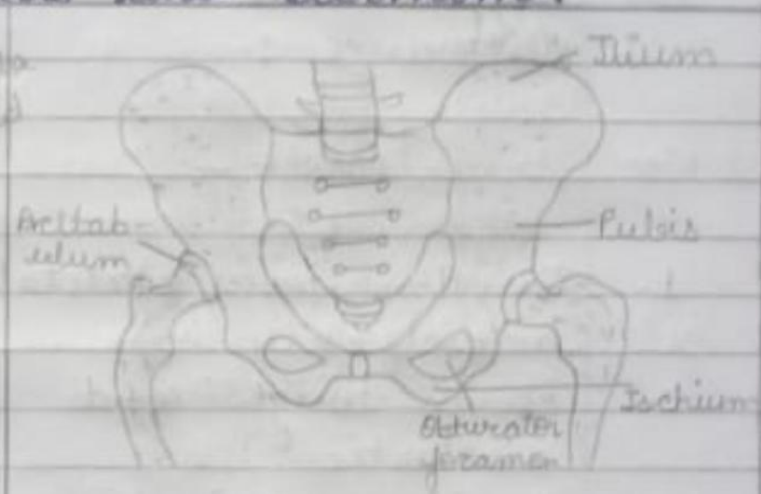


Fig:- Pelvic Girdle

2. Pelvic Girdle : Like pectoral girdle, pelvic girdle also has two two halves. But both halves are attached together at middle line by pubic symphysis. Pelvic girdle is located in the lower part of trunk b/w two legs. Each half consists of three bone - ilium, ischium and pubis. Ilium is a large bone located at anterior part dorsal. Pubis and ischium are located on ventral part along with anterior & posterior direction resp. In between the ischium and pubis Obturator foramen is found. Each half



DATE: / /

possess an acetabulum at outer edge where the head of femur articulates & pelvic joints is formed. Pelvic bones, sacral vertebra and coccygeal vertebra together with form pelvis.

5. Differentiate between Ligaments & Tendons.  
Difference :-

No.	Tendon	Ligament
1.	Tendon joins skeletal muscle to bone	Ligaments join a bone to another bone.
2.	It is tough and inelastic.	It is strong but elastic.
3.	It is modification of white fibrous tissue	It is a modification of yellow elastic tissue with some collagen fibres.
4.	Fibroblast lie in a almost continuous rows.	Fibroblasts lie scattered
5.	Fibres are seen as dense parallel bundles	Fibres are densely crowded but not arranged in parallel bundles.