Musculoskeletal System

Nutrition 2nd sem;
paper:- CT1

1. Draw the structure and write about skeletal Muscles.

Approximately 600 skeletal muscle composed of millions of muscle fibre, accounts 40-45% of the human body weight. Surrounding individual muscle fibre is the connective tissue called the Endomysium which combine small blood vessels and ~~neur~~ neurons.

Groups of muscle fibre collected into bundle of fascicles are found together by a more dense layer of colagenious and elastic fiber called Perimysium.

Finally the connective tissue which bind the fascicles into definite muscle is called Epimysium.

At the ends of elongated muscles the connective tissue forms a common bundles of fiber called Tendon.

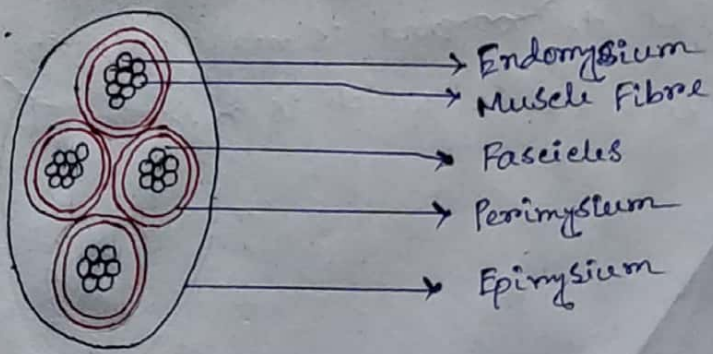


Fig:- Transverse section of skeletal muscle

Structure of Muscle Fibre :

Muscle
↓ composed
Units of muscle fibre
↓
Units of myofibrils
↓
Thin filament → Actin, Tropomyosin, Troponin
Thick Filament → Myosin protein (1500 in number)

Fig:- Structure of skeletal muscle

◉ Myofibril :-

Each muscle fibre consist of many myofibrils. Myofibril each about 1-2 μm in diameter and 1-4 cm in length. It is consist of myofilament. Myofilament made up thick and thin filament.

◉ Thick Filament :-

It is composed of myosin protein, molecular weight 4,80000 and is made up of 2 heavy chain and 4 light chain which is describe bellow —

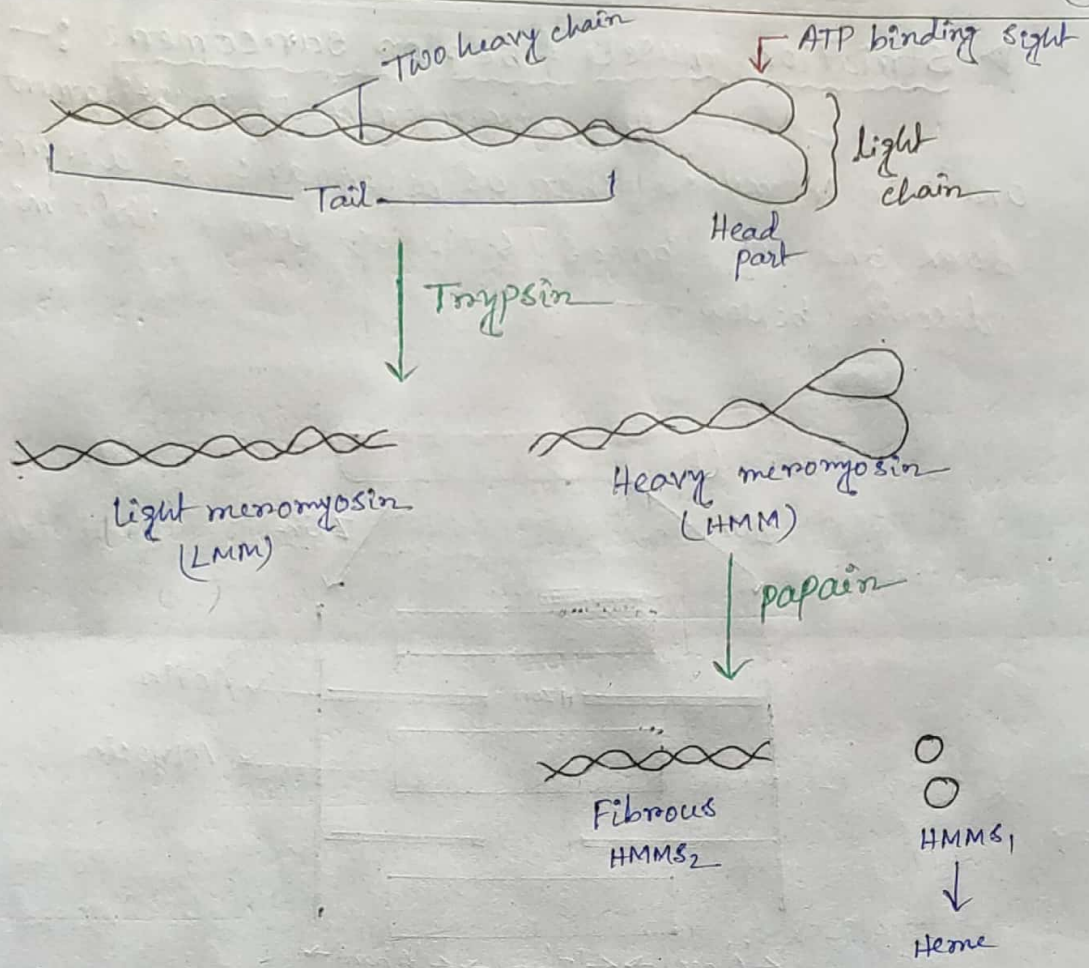


Fig:- Structure of Myosin protein and digestion with trypsin and papain

⊙ Thin filament :-

It is made up of contractile protein molecule known as actin and two regulatory protein molecule One tropomysin and troponin. This protein molecules are describe below in flow chart.

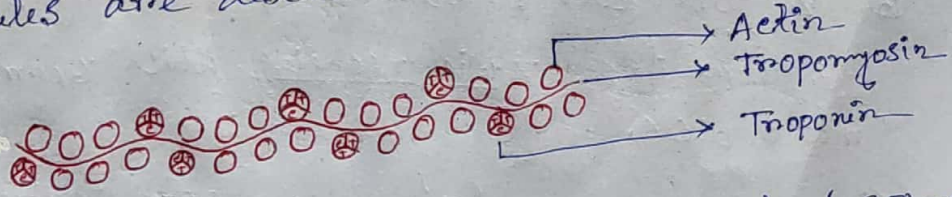


Fig:- Structure of thin filament composed of 300-400 actin 40-60 tropomyosin. Troponin molecule are composed of 3 subunits — Troponin-T, Troponin-I, Troponin-C

▶ Striation muscle fiber or sarcomere :—

The arrangement of myofilament (thick and thin) in muscle fiber as appearance of alternal dark and light bands (striation) under light microscope describe bellow —

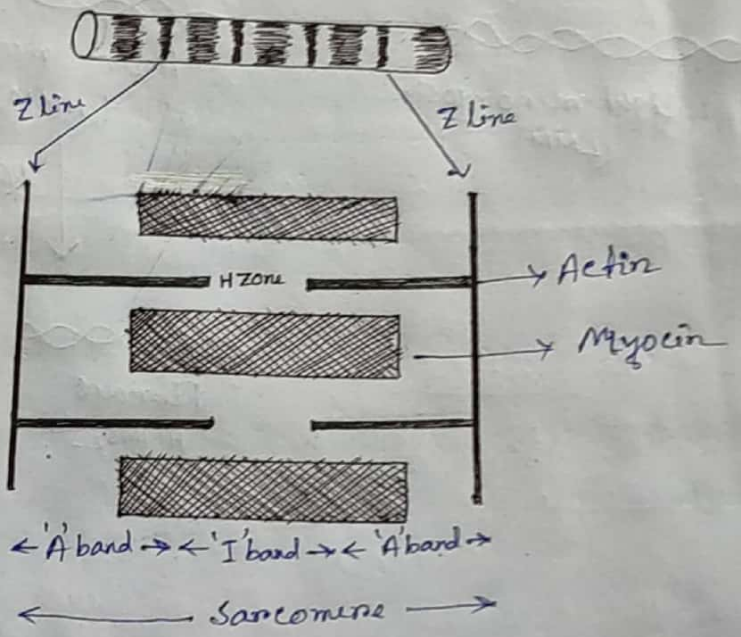


Fig:— Structure of sarcomere

① 'A' band is dark band length is 1.5 μm and line up thick and thin filament.

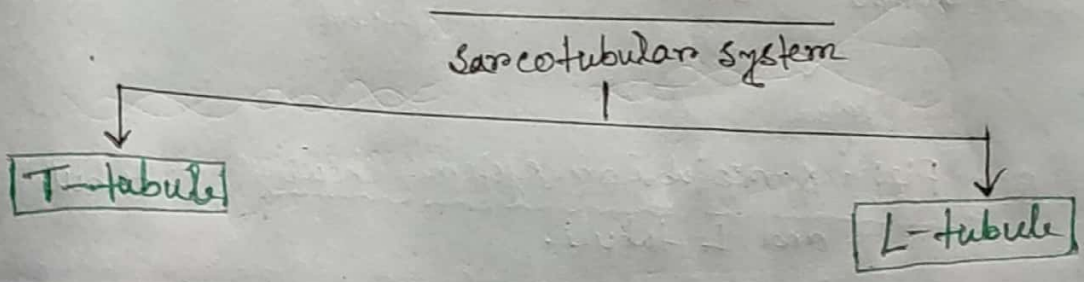
② 'I' band is about 1 μm length contains only actin filament.

③ 'Z' line each 'I' band is bisected by 'Z' line. Z come from Zwischenscheibe which German means discs.

④ In between two 'Z' line the portion is called Sarcomere.

Sarcotubular System :-

The Sarcotubular System composed of transver tubule (T-tubule) and Longitudinal tubule (L-tubule) and Sarcolemma (cell membrane of muscle fibre)

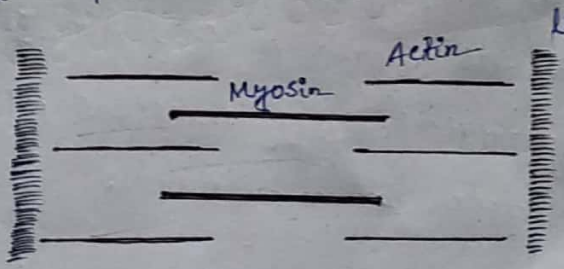


- **T-tubule :-** It is originated from Sarcolemma. The function of I and I band.

  - **Function:**
    T-tubule contain ca^{2+} receptor called dihydroperidin binding of ca in this receptor. just onset of muscular contraction.

- **L-tubule :-**
  L-tubule run in the long axis of muscle, fibre of the Sarcoplasmic reticulam myofibril. T-tubule and L-tubule joined in the term cisterne consised tried.

  - **Function:**
    It contained large amount of Ca^{2+} and help for muscle contraction.



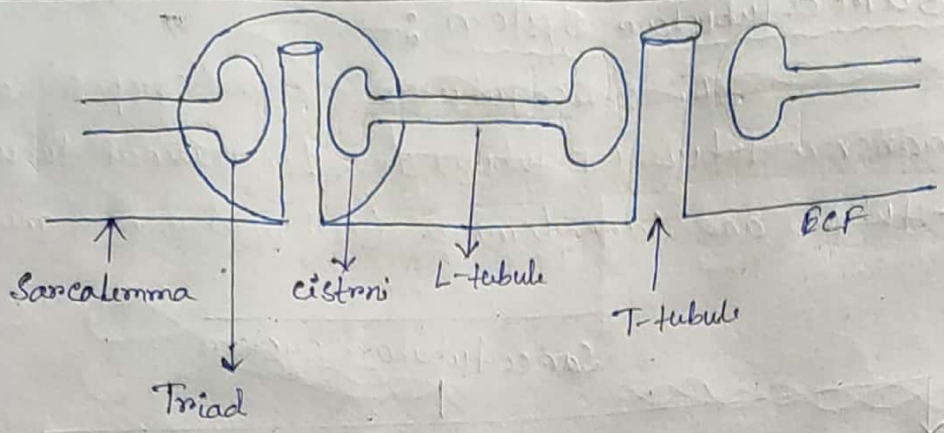


Fig:- sarcotubular system showing T-tubule and L-tubule.

2 Write the function of skeletal muscle.

⇒ In order for muscle to perform their function —

a) They are attached from bone across a joint or joint to another bone by tendon. That are form of colagen which is flexible to help easily movement of limbs.

b) Different muscle as agonists, synergistic and antagonist are involved in action for ~~Sim~~ Simplest movement of body.

c) The muscle which produces the movement is term the agonists while the muscle which apposers the movement is term the antogonist. The synergistic are muscles which act together to produce a movement.

e.g —

e.g.— Antagonistic muscles are the biceps brachii and triceps brachii.

If one holds a weight on the palmp of the hand by the biceps brachii (agonist) develops tension while the triceps brachii (antagonist) prevent the tension.

d) Over all striated muscle are associated with the movement of skeletal parts at the joint and maintenance of joint stability as related to posture.

e) Muscle serves as sphincters when they encircle an orifice. As for example — eyelid, lip and anus.

f) Striated muscle is found in the upper 2/3 of the esophagus in a tubular arrangement which aids in the swallowing mechanism.

g) The diaphragm is a thin muscular sheet which contraction associated with inspiration.

3. Write the sliding theory of skeletal muscle Contraction

⇒ AF Huseley and HE Huxley in 1954 explaining the sliding theory of actin filament over myosin filament formation actin-myosin complex during muscular Contraction. This theory of muscular Contraction explain in 5 steps described below —

Steps of Muscle contraction

- Initiation of cross Bridge cycle
- Formation of actin-Myosin Complex
- The power stroke
- Detachment of actin and myosin
- Reactivation of Myosin head.

⊙ Initiation of cross-bridge cycle :=

1. When Ca^{2+} difuse into sarcoplasm through 'L' tubule and 'T' tubule to bind troponin-c of actin filament.

2. Therefore, tropomyosin more laterally towards the head of the myosin molecules and initiated cross-bridge.

⊙ Formation of actin-myosin Complex :=

1. Head of myosin molecules bind with ATP and ATP is hydrolised by Ca^{2+} ATPase to genarate energy.

2. The activated myosin head extends perpendicularly towards to the actin filament and attach with actin.

⊙ The Power stroke :=

1. If the load on the muscle is small, then the actin filament slide over the myosin filament to produce muscle shortening.

2. If the load of muscle is large, then the actin filament are unable to slide over the myosin filament to produce stretching of the elastic near of the myosin molecule.

⊙ **Detouchment of Actin and Myosin :—**

When a new ATP molecule bind on myosin head results in desociation of actin-myosin complex.

⊙ **Reactivation of myosin head :—**

Freshly bound ATP on myosin head is reactivated in next muscle contraction.

◆ **Role of Ca^{2+} and Acetyle Coline (Ach) in muscle Contraction :—** Contraction and relaxation of skeletal muscle are control by calcium and acetyle Coline which is below in 7 steps —

1st step : Nerve Excitation :—

Action potential is produced in neuromuscular junction.

2nd step, Nerve Conduction :—

Genarated nerve impulse reach at synaptic region.

3rd step, Neuro muscular Transmission :—

Increase calcium permeability and inflow of Calcium from ECF to nerve terminal. Where as Ach is realeased to develop End plate protential (EPP).

4th step, Muscle Excitation :—

Depolarization of the muscle fibre occure due to development of EPP.

5th, step, Excitation Contraction Coupling :—

Calcium ions bind with troponin.

6th step, Muscle contraction :—

Activation of calcium ATPase enzyme in actine filament causes break down of ATP from myosin head and creat sliding of the thin filament over thick filament (cross bridge) to initiate muscle Contraction.

7th step, Muscle relaxation :—

Increased concentration of ADP and Pi block the calcium binding with ATPase and new ATP molecule bind with myosine head for next cross bridge cycle cause muscle relaxation.