MUSCLES

Muscle cells from the active contractile tissue of the body known as muscle tissue or muscular tissue. Muscle tissue functions to produce force and cause motion either location or movement within internal organs. Muscles cells are elongated and classified and or compatible as either striated muscles cells or smooth muscle cells depending on the presence or absence of organised, regularly repeated arrangements of myofibrillar contractile protein called myofilaments.

The muscles are of three types-

Stripped or skeletal muscle: -

1. They are voluntary muscle with somatic nerve supply.
2. They are multinucleated cells and appears striated or stripped due to the presence of light or dark bands. Hence they are also known as stripped ore striated muscle.
3. They usually remain attached with a bone (skeleton) via tendon or aponeurosis.
4. The junctional region between the somatic nerve and muscles is called neuromuscular junction. Acetyl choline (Ach) is the neuro-transmitter.
5. Many involuntary contractions for example reflax withdrawal of hand when a finger touches a hot: vessels are mediated by skeletal muscle although regulated by a different reflax mechanism.
6. Skeletal muscles do not contain pace maker.

Smooth muscle:-

1. This muscle lack distinct banding pattern and hence they appear as non- striated under the microscope.
2. They are not under voluntary control.
3. Smooth muscle are supplied by automatic nervous system (ANS). The neurotic-ammitter are acetylcholine, nor-adrenaline.
4. Smooth muscle cell contain only one nucleus per cell.
5. Most of them (expecting those of the eye) have pace makers. But unlike cardiac muscle these pace makers act a weakly and irregularly.

Cardiac muscle:-

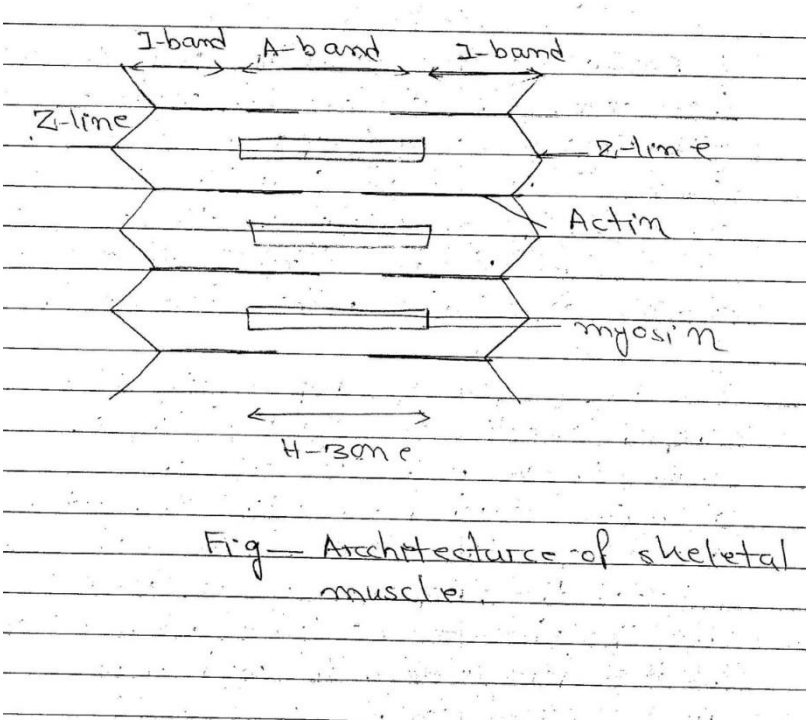
1. Cardiac muscles are striated in appearance due to the presence of light and dark banding patterns.
2. They are not under voluntary control.
3. A cardiac muscle cell known as cardio - myocytes consist of single nucleus.
4. Cardiac muscles are supplied by ANS.
5. The neurotransmitters are non- adrenaline (at sympathetic nerve ending) and acetyl choline (at parasympathetic nerve ending).
6. These muscles are functionally syncytium.
7. Cardiac muscle is specialized for performing contractile response and electrophysiological properties such as excitability, autorhythmicity and conductivity.
8. They are characterized by the presence of strong pace maker.

Functional architecture of skeletal muscle:

A muscle consist of a large no of individual myofibrils: The structure of a myofibrils is summarized as follow –

1. Each myofibrils contains J band and A band alternatively.
2. In the middle of the A-band a comparatively lighter Bone the H zone is present.
3. In the A band the myosin and actin filaments are present.
4. In the H-zone only a part of myosin filament is present and there is no action actin.
5. J-bands have no myosin and contain only actin filaments.
6. The functional unit of muscle contraction is known as sarcomere. A sarcomere consists of on full A-band and two half J-band.
7. Each myofibril is divided into a number of compartments by longitudinal Z-line. The portion between two adjacent Z-line constitutes a sarcomere.
8. Myosin and actin filament remain connected with each other by structure called cross bridges. The top of a cross bridge which has sites for attachment of actin and ATP is called myosin head.
9. A fine line known as the Hensen's line is present in the H-zone.

10. Each myosin filament is surrounded by 6-actin filament.



Fig— Architecture of skeletal muscle.

Muscle Protein

Within the muscle cells there are at numbers of proteins which play a vital role during muscle contraction and relaxation. The major components protein maybe distinguished as proteins constituting the thick filament and the thin filaments respectively.

1. **Thin filament:** The thin filament contains three types of protein.
    A. **Actin:** It is a globular protein which has sites for attachment with various ions, ATP, myosin and troponin. In the monomer from it is called G-actin.. The G-actin undergo polymerization to form F-actin. Two polymers of actin i.e. two F- actin chains constitute a thin filament.
    B. **Tropomyosin:** Tropomyosin is a rod shaped protein molecule which consist of two chains in an α-helical coil arrangement. It remains attached to actin and lies in the grooves of actin filament. When the muscles relaxed the tropomyosin is placed in such a way that the sites in the actin which are meant for attachment with myosin head farce covered so that myosin head cannot bind to/with actin.
    C. **Troponin:** Troponin is a complex of three proteins-
        a. Troponin I, which is an inhibitory proteins that prevents the association of action and myosin.
        b. Troponin C, which has binding site for ca^{2+} ion, and
        c. Troponin T, which binds with tropomyosin.

        Troponin-tropomyosin complex prevents the formation of bridges between actin and myosin filaments when no contraction occur.
2. **Thick filament:** Most of the thick filament is made up of myosin protein - myosin II, constitute the thick filament while myosin I is a member of non-muscle contractile thick protein. In addition the thick filament also contain other protein such as c-protein.

    Myosin: Myosin composed of 6 polypeptide chains. 2 heavy chain and 4 light chains with a molecular weight of about 200,000 each for heavy chain and 20,000 each for light chain. The two heavy chains wrap spirally around each other to form a double helix, which is called the tail of the myosin molecule. One end of each of these chains is folded bilaterally into a globular polypeptide structure called a myosin head. Thus, there are two free heads at one of the double

helix myosin molecules. The 4 light chains are also part of the myosin head, two to each head. These light chains help control the function of the head during muscle contraction.

Function of myosin:

1. Myosin is a motor molecule that works to move the cell. This will result in a contraction and expansion movement.
2. It works closely with a globular protein called actin that polymerizes to create to actin filaments.
3. Most myosin molecules are composed of both a head and a tail domain. The head domain binds the filamentous actin, general force and to "walk" along the filament towards the +ve end.
4. They convert ATP to energy of motion.

Sliding filament theory of muscle contraction:

The sliding filament theory was proposed by A. F Huxley and H.E Huxley in 1950s to explain the mechanism of muscle contraction. According to this theory muscle contraction takes place by sliding of the actin and myosin filaments over each other and not by contraction of the filaments as thought earlier. At the time of muscle contraction the actin filament move deeper into the J-band towards the H-zone. The cross bridges which arise from the myosin filament possesses ATPase activity and can combine with actin. The sliding filament theory is now known as the cross-bridge theory or Ratchet theory. In the present form according to this theory –

A. Myosin head developed contact with the active molecule. The thick filament can be visualized as a short of boat and the myosin head as oars. The oars are the cross I bridges connecting myosin with the actin.
B. The myosin heads rotate and the actin filament is push towards the H-zone.
C. The myosin head detach from the actin molecule and reattach with the adjacent new site in the actin molecule.
D. The whole cycle of attachment of (myosin head » swiveling detachment » reattachment) is repeated many time bringing about the shortening of the sarcomere. This is known as the cross bridge cycle or sliding as previously called in the sliding filament theory.
E. All the myosin head attached and swivel simultaneously and there force their affect are additive like a power stroke.
F. There are two types of contraction-
    a) Isotonic
    b) Isometric

    In isotonic contraction the muscle as a whole contracts and shortens but in the isometric contraction the muscle as a whole contracts but does not shorten.

    Thus the sliding filament theory, notes that-

    a) At rest the H-zone is wide and I bands are wide.
    b) In the contracted state H-zone become greatly narrow or disappear the width of the J-band is reduced.
    c) The sarcomere as a whole shortened in muscle contraction but the length of the filament remain same.

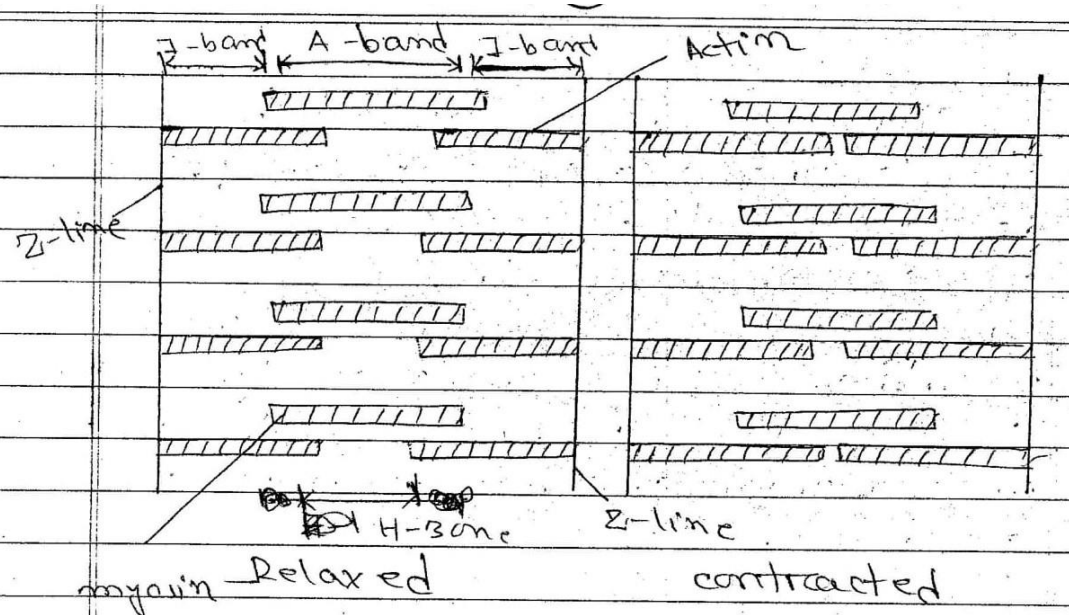


Fig – Sliding filament theory of muscle contraction

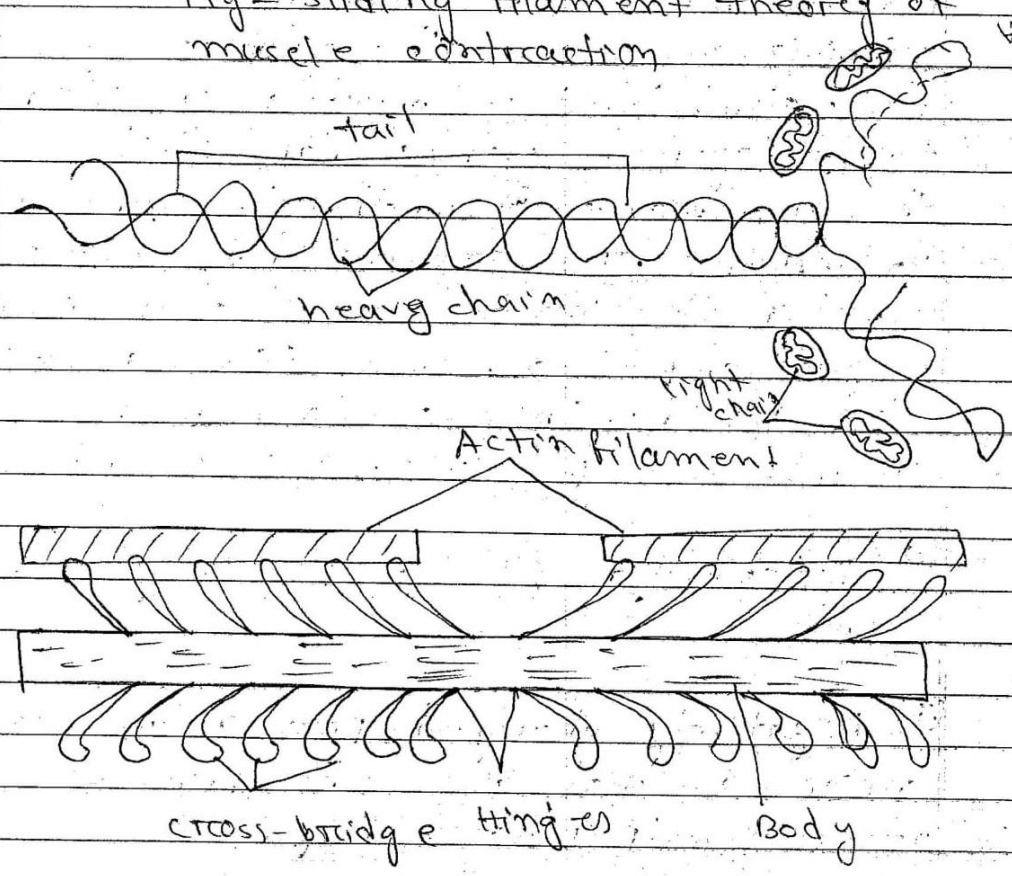


Fig – Myosin molecule

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