Page No.
Date

Muscle

(1) Skeletal or Straited muscles (associated with bones and under the voluntary control)
(2) Smooth → Present in any tube or sac around the organs - involuntary
(3) Cardiac → They are Straited but they are involuntary.

Muscles can be of three types based on structure, contractile properties and control mechanism.

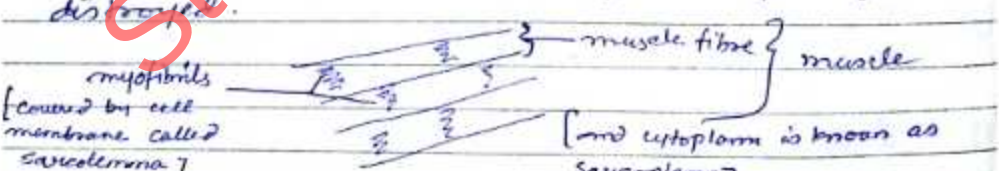
(1) Skeletal muscle (2) Smooth (3) Cardiac muscle

The skeletal muscle is associated with bones and under the voluntary control.

Structure

A single skeletal muscle cell is known as muscle fibre and it is formed by the fusion of many undifferentiated mononucleated cells called the myoblasts. Thus the muscle fibres are the multinucleated cells.

- These are satellite cells present adjacent to mature skeletal fibre that can undergo differentiation and form muscle fibre if they are disrupted.



- A no. of muscle fibres surrounded by connective tissue is known as muscle. muscles are linked to bones by tendons that are collagen fibres. The skeletal and the cardiac muscles

are also known as straited muscle. This pattern arises due to the arrangement of various thick and thin filament in the cytoplasm of muscle fibre. These bundles are termed as myofibrils.

P.M of myofibrils / muscle fibre — Sarcolemma
Cytoplasm " " — Sarcoplasm
ER " " — Sarcoplasmic Reticulum
Store Store Ca^{2+}

The thick and thin filaments are arranged alternatively in repeating pattern and a single unit of this pattern is called as Sarcomere.
[functional unit of muscle]

A- Stands for Anisotropic (light cannot pass through it)
I- Stands for Isotropic (light can pass through it)
M-line - the protein bridge join myosin together.

The thick filaments are composed of myosin & the thin filaments are made up of actin, tropomin and tropomyosin. The thick filament lies in the middle of each sarcomere this region is known as A-band [Anisotropic].
On either side of this bands are the ~~set~~ two set of thin filament. One end of each

thin filament is anchored to a network of interconnecting proteins forming the Z-lines. The other end overlaps with the thick filament. Thus, a sarcomere is limited by the two Z-lines. On the either sides of A-band lies I-band. I-band containing the non-overlapping thin filaments. In the A-band their is the light band called H-zone that contains exclusively thick filaments. In the centre of the H-zone there is the M-line that is made up of protein that link the central region of adjacent thick filaments. Also, there is a protein called titin that links the Z-line to the M-line. The myosin molecules of the thick filament gives rise to projections called as cross-bridges that links thick and thin filament.

Sliding filament Mechanism of Muscle Contraction

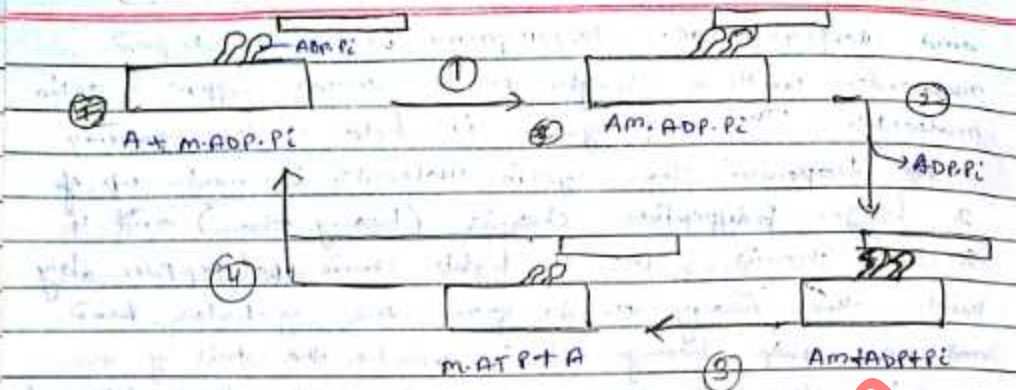
During shortening of skeletal muscle, the myosin cross bridges are attached to actin molecule of the thin filament. It then moves thereby bringing the thin filament closer to each other towards the centre of Sarcomeres. As the filaments slide to cause Sarcomere shortening, this is known as sliding filament mechanism.

Actin is a globular molecule made up of single polypeptide chain of polymerases with other actin to form two intertwined helical chains. These make up the thin filament along with tropomin

and tropomyosine. Tropomyosin is a rod-shaped molecule with a length which covers approx 7 actin molecules. The tropomyosin is held in this position by troponin. The myosin molecule is made up of 2 large polypeptide chains (heavy chains) and 4 smaller chains. The 4 light chain polypeptides along with the heavy chains form the globular head and the two heavy chains make the tail of the myosin that lies along the axis of the thick filaments. The head contains the binding site for ATP and another for actin, the myosin molecule from the two ends of the thick filament lies on the opposite direction that is tail ends directly towards the centre. This helps in power stroke of cross bridge that moves the attach thick thin filaments towards the centre.

Cross Bridge Cycle

Binding of the cross bridge to Actin, movement and then repetition of this process is known as cross-bridge cycle. The energy state in the cycle is low and hence the cross bridge cannot bind to Actin. The cross bridges are energised by splitting energy and the hydrolysis products are bound to myosin.



Steps :

(1) When there is ↑sc. in calcium, the energised myosin bridge binds to the actin filament.

$A + M.ADP.Pi \longrightarrow Am.ADP.Pi$

(2) The cross-bridge now moves [Power Stroke] as binding releases the strained conformation of the cross bridge, then Pi and ADP are released.

$Am.ADP.Pi \longrightarrow Am + ADP + Pi$

(3) Now new ATP is attached to the cross-bridge of myosin and the link b/w actin-myosin is broken

$Am + ATP \longrightarrow M.ATP + A$

(4) The ATP is split, leading to the energised state of the myosin.

$A + MATP \longrightarrow A + MADP.Pi$

If calcium is present again, the cycle starts.

Rigor mortis

Page No.
Date / /

ATP plays two important role. –

(1) It helps in the cross-bridge movement [by energising the myosin cross-bridge].
(2) It is responsible for breaking the link b/w actin and myosin.

- In case of death, after some hrs, when the ATP conc^{n} is depleted, then Actin and myosin remain Contracted and breakage of the link does not takes place. This produces a rigid condition called Rigor-mortis

- The troponin has 3 Subunit.

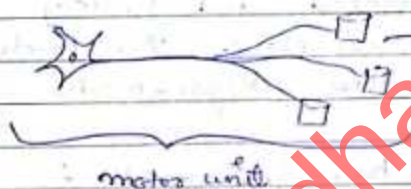
(1) I – inhibitory
(2) T – tropomyosin binding
(3) C – calcium binding

When the Calcium conc^{n} rises it binds to the troponin thereby causing it to change. It drags the tropomyosin along. Thus, Vacating the myosin binding site present in Actin. The Ca^{2+} is stored in the sarcoplasmic reticulum which is similar to ER and forms a mesh-work around each myofibril.

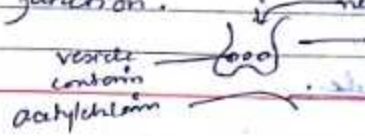
There are lateral Sacs present at the end of each segment that stores calcium. In b/w two lateral sacs lies the T-tubule also called the transverse-tubule.

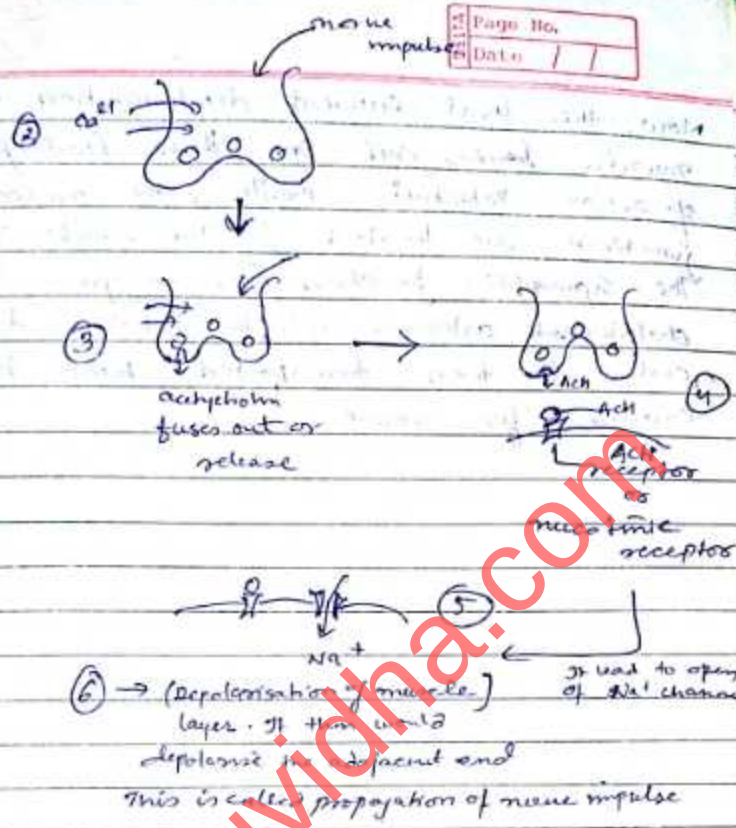
The calcium is released from the lateral sac of the sarcoplasmreticulum into the cytoplasm thus activating the cross-bridge cycle. The Ca^{2+} conc^{n} is later decrease by pumping the Ca^{2+} back into the sarcoplasma by Ca^{2+} ATPase. ATP is required for pumping back Ca^{2+} into the SR. (Sarcoplasma reticulum).

Neural Control of skeletal Muscle



Motor neurons innervate the skeletal muscle fibre. They arise from the spinal cord or the brain stem, that is, the cell body are present there in. These motor neurons have myelinated axons. The axon branch and each branch makes contact with the muscle fibre. Thus, each motor neuron innervates 2 or more of muscle fibre. The motor neuron and the muscle fibre it innervates is called as a motor unit. The axon terminal contain vesicle having neuro-transmitter acetylcholin. The region of the plasma membrane of muscle fibre lying immediately below the terminal of the axon are called motor end plate. The junction of motor end plate with axon terminal is called as neuromuscular junction.





This is called propagation of nerve impulse

⑦ → Propagation of depolarisation to adjacent side.

- Neuromuscular junction — Junction b/w end of neuron and muscle end plate.

Steps: When action potential is initiated it propagates to motor neuron axon terminal. The depolarisation leads to opening of the Ca^{2+} channel the Ca^{2+} entry triggers the release of Ach (acetylcholine) The vesicle containing Ach fuse with the P.M. thereby releasing Ach in cleft b/w axon terminal and motor end plate. The acetylcholin binds to the nicotinic receptor or motor end plate. This leads to opening of Na^+ and K^+ channel. more Na^+ moves in than K^+ moves out, thus, leading to depolarisation of muscle fibre membrane. This is known as end-plate potential (EPP).

Now, the local current depolarisation the adjacent muscle. ~~layer~~ cell pm thus leading to propagation of action potential. mostly, the neuromuscular junctions are located in the middle of the muscle fibre. The synaptic junction has enzyme called acetyle cholinesterase acetase. which breaks down acetylcholine choline is then transported back to the axon terminal for reuse.