Locomotion and Movement (Muscles)

Movement : Any type of change in position and posture of an organism / organ of body is called movement.
Locomotion : Displacement movements are called locomotion.
Locomotion vs Movement : All locomotion's are movements but all movements are not locomotion's.
Types of movement:
Cells of the human body exhibit three main types of movements, namely
(i) Amoeboidal (ii) Ciliary (iii) Muscular

(i) Amoeboidal : Some specialised cells in our body like macrophages and leucocytes in blood exhibit amoeboid movement. It is effected by pseudopodia formed by the streaming of protoplasm (as in Amoeba). Cytoskeletal elements like microfilaments are also involved in amoeboid movement.

(ii) Ciliary Movement : Ciliary movement occurs in most of our intemal tubular organs which are lined by ciliated epithelium. The coordinated movements of cilia in the trachea help us in removing dust particles and some of the foreign substances inhaled along with the atmospheric air. Passage of ova through the female reproductive tract is also facilitated by the ciliary movement.

(iii) Muscular : Movement of our limbs, jaws, tongue, etc, require muscular movement. The contractile property of muscles are effectively used for locomotion and other movements by human beings and majority of multicellular organisms.

- Movement of human sperm occur by flagella.

Muscles

- Study of muscles known as **Myology / Sarcology.**
- All muscles of body develop from **mesoderm** but muscle of Iris and Ciliary body are ectodermal in origin.
- They have special properties like **excitability**, **contractility**, **extensibility** and **elasticity**.
- About **40-50 percent** of the body weight is contributed by muscles.
  Three types of muscles are found in the body.
  (i) Voluntary or skeletal muscles. **(ii)** Involuntary or smooth muscles.
  (iii) Cardiac muscles (Heart).

Voluntary Muscles

- They are related to the skeletal system. So also called as **skeletal muscles.**
- Transverse lines are found at regular interval. Hence these muscles are also called as **striped or striated muscle.**
- Each organised skeletal muscle in our body is made of a number of muscle bundles or fascicles held together by a common collagenous connective tissue layer called fascia.
- They are primarily involved in locomotory actions and changes of body postures.
- Their contractions are controlled by will power of animal so also called **voluntary muscles.**

  Muscle fibre is covered by a layer of connective tissue which is called **endomysium.**

  Many muscle fibres are combined to form muscle bundle which is called **fassicle.**

  Each fasciculi is covered by a layer of connective tissue which is called **perimysium.**

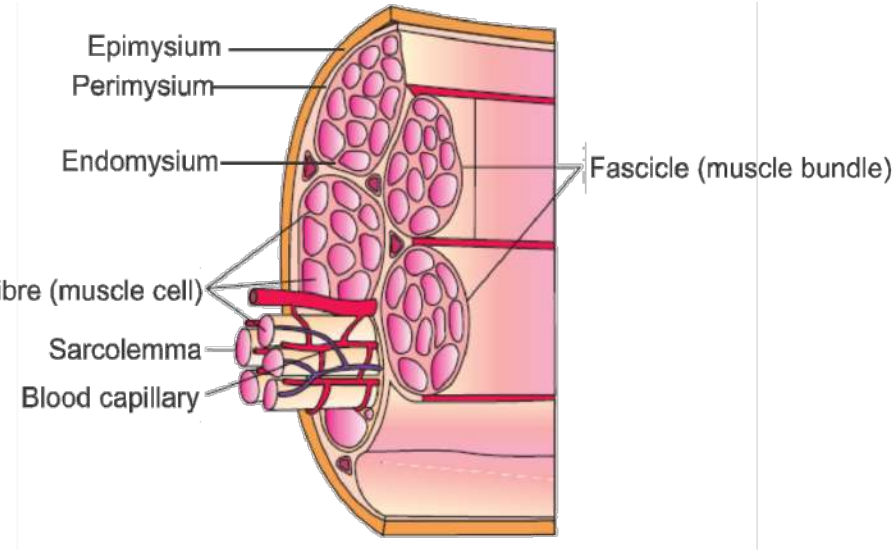
  A number of muscle bundles are covered by common collagenous sheath called **fascia.**

  Many fasciculi combined to form a **muscle.**

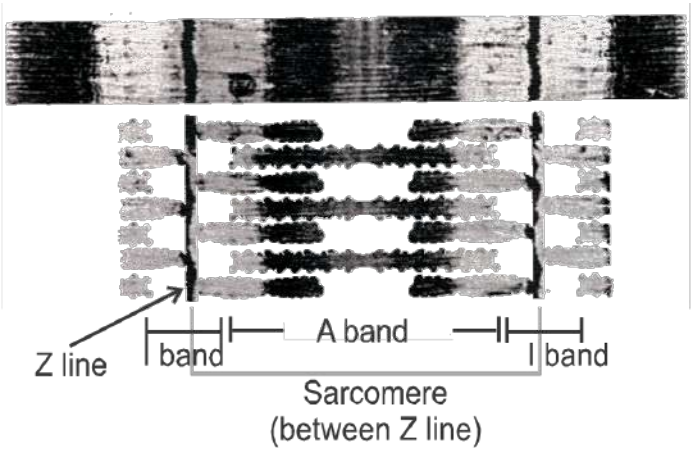
  Muscle is also covered by a layer of connective tissue which is called as **epimysium.**

  The muscle fibres attached to a tough cord of *dense regular connective tissue* called **tendon** & it is further attached with a bone.

Structure of Muscle Fibre



Diagrammatic cross sectional view of a muscle showing muscle bundles and muscle fibres



Diagrammatic representation of anatomy of a muscle fibre showing a sarcomere

Fine Structure of Muscle Fibre :

- Skeletal muscle fibre is a cylindrical or tubular shape, long and Unbranched.
- The outer membrane of muscle fibre is called **sarcolemma.**
- Each muscle fibre contain multinucleated sarcoplasm i.e. syncytium.
- Nucleus & sarcoplasm are found in peripheral part.
- Endoplasmic reticulum of muscle fiber is store house of calcium ions.
- Myofibril are arranged in parallel row & form the dark & light line.
- These lines are found in alternate order.
- These lines are made up of actin & myosin protein. Both proteins are **filamentous proteins**.
- Actin filaments are **thin** while myosin filaments are **thick**.
- Light line or band is made up of only actin filament, these band are mono-refractive in polarised light so it is called **Isotropic band** (I band).

- The dark band called 'A' or Anisotropic band contains myosin.
- Both the proteins are arranged as rod-like structures, parallel to each other and also to the longitudinal axis of the myofibrils.
- In the centre of each I band is an elastic fibre **called 'Z' line** which bisects it. The thin filaments are firmly attached to the *'Z:* line. The thick filaments in the 'A' band are also held together in the middle of this band by a thin **fibrous membrane** called **'M' line**. The 'A' and I bands are arranged alternately throughout the length of the myofibrils. The portion of the myofibril between two successive 'Z' lines is considered as the functional unit of contraction and is called a **Sarcomere.** In a resting state, the edges of thin filaments on either side of the thick filaments partially overlap the free ends of the thick filaments leaving the central part of the thick filaments. This central part of thick filament, not overlapped by thin filaments is called the **'H' zone.**
- **Sarcomere** is considered as the **functional unit** of contraction.

  Sarcomere = 1A band + two half I band

  The Length of Sarcomere is 2.5 μm.

  (I band = 1μm, myosin = 1.5 μm)
- 1 Myosin filament is surrounded by 6 Actin filaments & 1 Actin filament is surrounded by 3 Myosin filaments.
- Z-disc madeup of **actinin protein.**

Structure of Contractile Protein

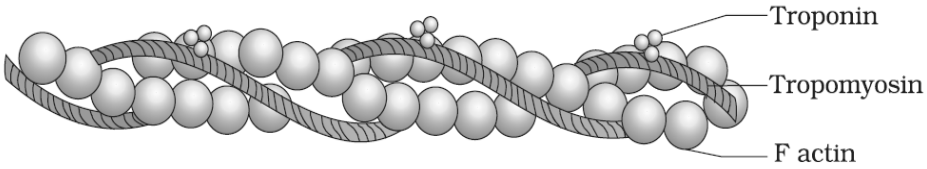
1. **Actin (Thin Filament) :**

   Each actin (thin) filament is made up of two 'F (filamentous) actins helically wound to each other. Each 'F actin is a polymer of monomeric 'G' (Globular) actins.

   Two filaments of another protein, tropomyosin also run close to the 'F' actins throughout its length.

   A complex protein Troponin is distributed at regular intervals on the tropomyosin.

   In the resting state, a subunit of troponin masks the active binding sites for myosin on the actin filaments.



An actin filament

   Troponin is made up of three subunit.

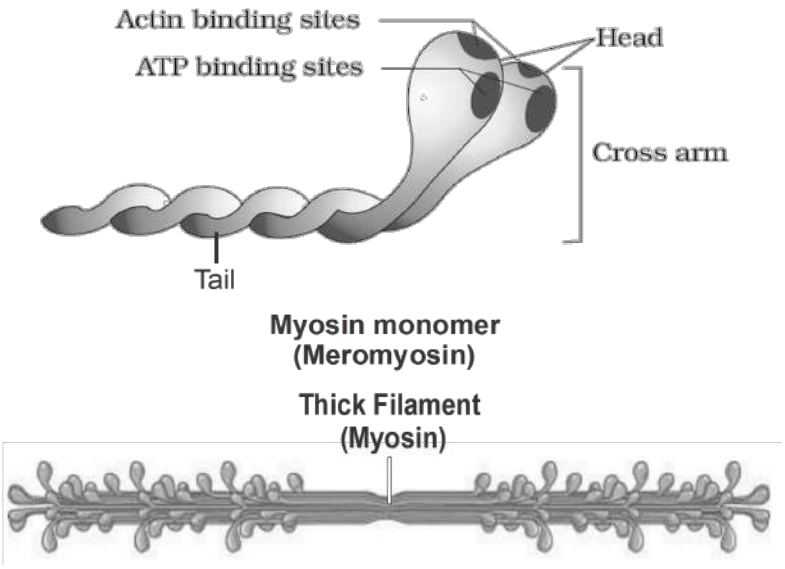
   (a) Troponin I (Inhibitory site)

   (b) Troponin T (Tropomyosin site)

   (c) Troponin C (Ca^{+2} binding site)

2. **Myosin (Thick Filament) :**

   Each myosin (thick) filament is also a polymerised protein. Many monomeric proteins called Meromyosins constitute one thick filament.



Each meromyosin has two important parts, a globular head with a short arm and a tail, the former being called the heavy meromyosin (HMM) and the later, the light meromyosin (LMM).

The HMM component, i.e.; the head and short arm projects outwards at regular intervals and is known as cross arm.

The globular head is an active **ATPase enzyme** and has binding sites for ATP and active sites for actin.

Concept Builder

1. Amoeboid movement in macrophages & WBC are effected by :
(1) Cilia (2) Flagella (3) Pseudopodia (4) Pseudocoel

2. Which type of muscle is present in alimentary canal :-
(1) Smooth muscle fibre (2) Striped muscle
(3) Cardiac muscle (4) Both A & B

3. Muscle bundles or fasicles held together by common collagenous tissue layer called :-
(1) Motor end Plate (2) Motor unit (3) Fascia (4) Neuromuscular Junction

4. Muscle with characteristic striation and involuntary are :-
(1) Muscle in walls of alimentary canal (2) Muscles of Heart
(3) Muscle assisting locomotion (4) Muscles of eyelid

5. Component of actin filament of sarcomere is :
(1) Myosin & Troponin (2) Troponin & Actin
(3) Actin & Myosin (4) Actin, troponin, tropomyosin

6. ATPase of muscle is located in :
(1) Actinin (2) Troponin (3) Myosin (4) Actin

Concept Builder (Answer-Key)						
Que.	**1**	**2**	**3**	**4**	**5**	**6**
Ans.	3	1	3	2	4	3

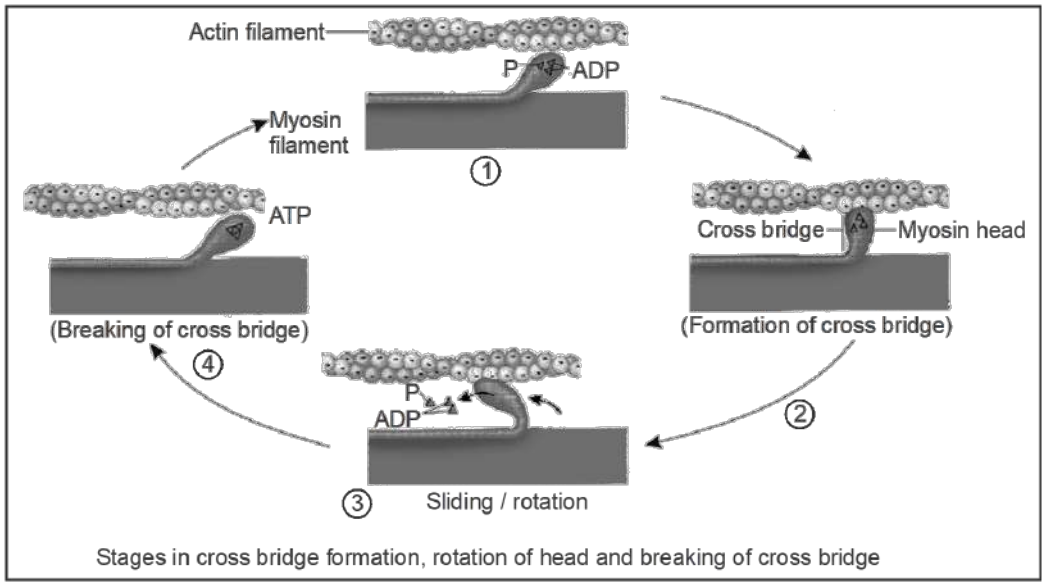
Mechanism of Muscle Contraction

- Mechanism of muscle contraction is best explained by the **sliding filament theory** which states that contraction of a muscle fibre takes place by the sliding of the thin filaments over the thick filaments.
- Muscle contraction is initiated by a signal sent by the central nervous system (CNS) via a motor neuron. A motor neuron along with the muscle fibres connected to it constitute a **motor unit.** The junction between a motor neuron and the sarcolemma of the muscle fibre is called the **neuromuscular junction or motor-end plate.** A neural signal reaching this junction releases a **neurotransmitter (Acetylcholine)** which generates an action potential in the sarcolemma.
- This spreads through the muscle fibre and causes the release of calcium (Ca^{+2}) ions into the sarcoplasm.
- Increase in Ca^{++} level leads to the binding of calcium with a subunit of troponin on actin filaments and thereby remove the masking of active sites for myosin.
- Utilising the energy from ATP hydrolysis, the myosin head now binds to the exposed active sites on actin to form a **cross bridge.**
- This pulls the attached actin filaments towards the centre of 'A' band. The 'Z' line attached to these actins are also pulled inwards thereby causing a shortening of the sarcomere, i.e., contraction.
- During shortening of the muscle (contraction), the I bands get reduced, whereas the 'A' bands retain the length.
- The myosin, releasing the ADP and Pi goes back to its relaxed state. A new ATP binds and the cross-bridge is broken.
- The ATP is again hydrolysed by the myosin head and the cycle of cross bridge formation and breakage is repeated causing further sliding.
- The process continues till the Ca^{++} ions are pumped back to the sarcoplasmic cisternae resulting in the masking of actin filaments.
- This causes the return of 'Z' lines back to their original position, i.e., relaxation.
- Repeated activation of the muscles can lead to the accumulation of lactic acid due to anaerobic breakdown of glycogen in them, causing **fatigue**.

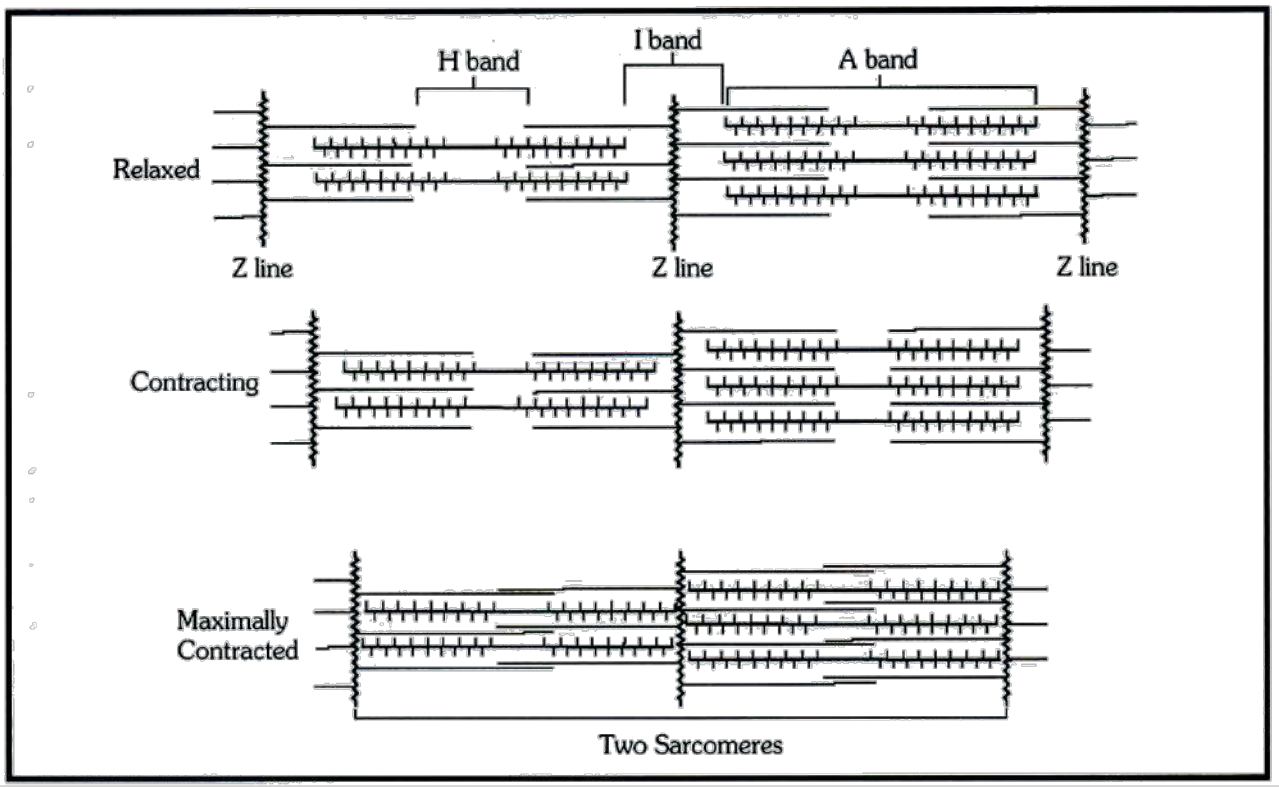
Role of ATP :

(i) The 'back & forth' movement of myosin head with in the groove.

(ii) Deattachment of myosin head from the actin.



Stages in cross bridge formation, rotation of head and breaking of cross bridge



Difference Between Red Muscle and White Muscle

	Red (slow) Muscle		White (fast) Muscle
1	Myoglobin content is high. So, it is red	1	Myoglobin content is less So, it is pale
2	Sarcoplasmic reticulum is less extensive	2	Sarcoplasmic reticulum is more extensive
3	Blood vessels are more extensive	3	Blood vessels are less extensive
4	Mitochorndria are more in number	4	Mitochondria are less in number
5	Response is slow with long latent period	5	Response is rapid with short latent period
6	Contraction is less powerful	6	Contraction is more powerful
7	This muscle is involved in prolonged and continued activity as it undergoes sustained contraction	7	This muscle is not involved in prolonged and continued activity as it relaxes immediately
8	Fatigue occurs slowly	8	Fatigue occurs quickly
9	Depends on cellular respiration for **ATP** production so also called aerobic	9	Depends on anaerobic process for energy

- Marathon athletes develops red fibre in thigh muscle due to repeated contraction.

Concept Builder

1. Anisotropic band is made of :-
(1) Myosin filament (2) Actin filament (3) Elastin filament (4) All the above

2. In which step of muscle contraction energy is utilised in the form of ATP ?
(1) Release of Ca+ ions into sarcoplasm (2) Formation of cross bridge
(3) Breaking of Cross bridge (4) Both B & C

3. Red muscle fibre are rich in :
(1) Golgi bodies (2) Mitochondria (3) Lysosome (4) Ribosome

4. Muscle band that remains unchanged during contraction & relaxation of skeletal muscle is :-
(1) I-band (2) H-zone (3) A-band (4) Z-line

5. During contraction of muscle Ca^{+2} attach to :-
(1) Troponin (2) Tropomyosin (3) Actin (4) G-Actin

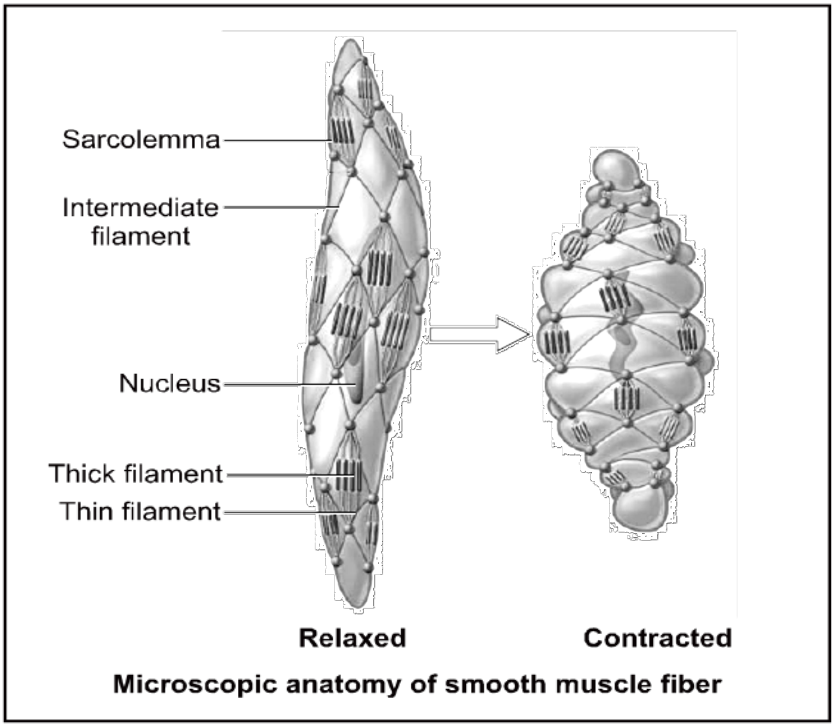
Concept Builder (Answer-Key)					
Que.	**1**	**2**	**3**	**4**	**5**
Ans.	1	2	2	3	1

Involuntary Muscle

- It is not related to the skeleton so also called as **Non skeletal muscle.**
- These muscle are found in the visceral organ so are called as **visceral muscles or smooth muscles.**
- Transverse lines are absent so also called as **unstriated muscle.**
- Its contraction is not controlled by will power of animal. so it is called as **Involuntary muscle.**
- Autonomic nerves are connected to this type of muscle.

Structure of Smooth Muscle Fibre

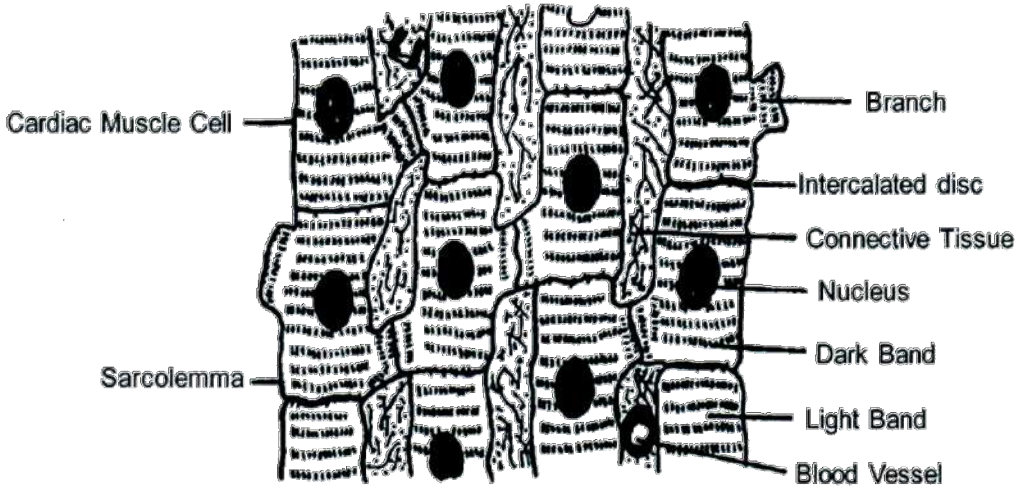
- It is short, spindle shaped, unbranched.
- Cells are connected through **gap junction**.
- It contains uninucleated cytoplasm
- All cell organelles are found in cytoplasm.
- Contractile fibrils are found in the cytoplasm due to this reason this cytoplasm called **sarcoplasm.**
- This contractile fibre called as myofibril which found in scattered form.
- Myofibril are made up of actin & myosin but remarkably less than skeletal muscle but filaments are not placed in a highly ordered pattern so striation is absent.
- Actin is more than myosin.
- ***Myofibril*** *is functional unit of involuntary muscle*.
- The sarcoplasmic reticulum or L tubular system is not well developed. This makes the contraction of smooth muscles strongly dependent on the **ECF** Ca^{++} **ions.**
- Its contraction period is longer.
- It remain in contracted stage for longer period. Due to this reason muscle called **non fatigue muscle.**



Microscopic anatomy of smooth muscle fiber

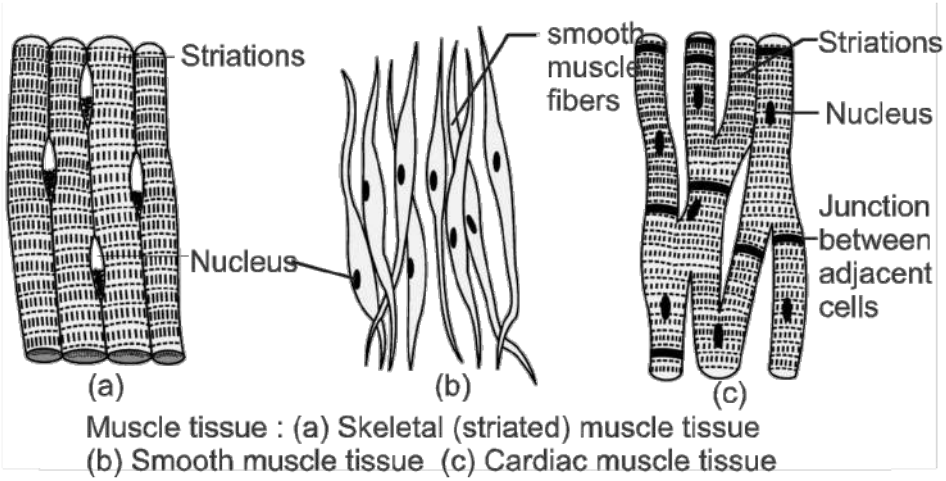
Cardiac Muscle

- It is special type of muscle which found only in heart so it is also called as cardiac muscle. On the basis of structure it is **striated type of muscles.**
- Their muscle fibres are long, cylindrical and branched.
- Many transverse septa are found in the muscle fibre which are called as **intercalated disc.** *They help in the propagation of impulse and contraction*.
- Due to septa fibres are divided into many segments each segment is **uninucleated.** Each segment called individuals cells.
- Dark & light line also found in the Muscle fibre. It is also **non fatigue type muscle.**
- Its contraction is not controlled by will power of animal.
- On the basis of function it is **smooth muscle type.** Both central and autonomic nerves are supplied to this type of muscle.



Difference Between Striated, Non-Striated and Cardiac Muscle

	Striated / Skeletal	Non striated / Smooth	Cardiac
1.	They are present in upper limb & lower limb etc.	Iris of eye (Ciliary muscle of eye) Urinary bladder, Urinogenital tract, Dermis of skin - Erector pill muscle of dermis	They are present in walls of Heart
2.	Cylindrical	Spindle in shaped	Cylindrical
3.	Fibres Unbranched	Unbranched	Fibres are branched
4.	Multi Nucleated fibres	Uninucleated	Uninucleated
5.	Light and Dark band present	Absent	Present
6.	Oblique bridges & Intercalated disc absent	Absent	Present
7.	Controlled by CNS.	ANS	Both CNS + ANS
8.	Blood supply abundant.	Less	Richly Blood supply
9.	Soon fatigue.	Donot get fatigue	Never fatigued



Muscle tissue : (a) Skeletal (striated) muscle tissue (b) Smooth muscle tissue (c) Cardiac muscle tissue

Properties of Muscles

1. **Paralysis :** Supply of motor nerve impulse completely cut off. So function of muscle contraction is stopped.
2. **Shivering :** Involuntary contraction of skeletal muscles to make body warm.
3. **Muscle Tension :** Force produced during contraction of muscle is known as muscle tension.

Two Types of Muscle Contraction

Isometric Contraction	Isometric Contraction
Length same but tone changed (Work done is zero) E.g. Pushing against an immovable object.	Length changed but tone same E.g. Walking, Load is lifted.

4. **Rigor Mortis :**
   After death, fresh supply of ATP become impossible so once the local store of ATP molecule are exhausted. Due to non availability of ATP / C.P., detachment of myosin from actin cannot take place resulting in permanent state of contraction of muscle. This phenomenon is called rigor mortis. This condition helps fixation of the hour of death.
5. E.D.T.A. (Ethylene Diamine tetra acetic acid) injected inside muscle combined with Ca^{+2} and stops contraction.
6. Muscle and nerve excitability is reduced by K^+.
7. During muscle contraction chemical energy changed into mechanical energy.
8. Over stretching of ligament is called **sprain**.
9. Over stretching or tearing of muscles or tendon is called strain.
10. **Phosphagens :** These are highly energy N-based compounds which are found in the muscles. In the invertebrates **arginine phosphate** and in the vertebrate **creatine phosphate** act as a phosphagens. These compounds provide energy during contraction.

    Creatine phosphate + ADP $\underset{\text{at rest state}}{\overset{\text{Muscle contraction}}{\rightleftharpoons}}$ Creatine + **ATP**

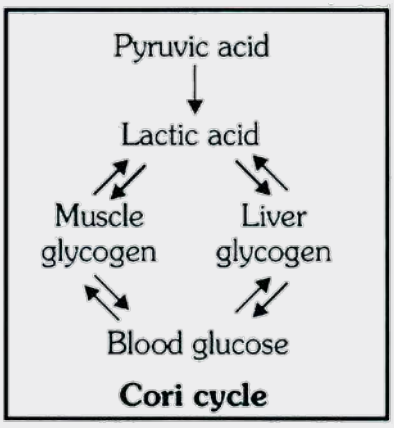
11. In the muscles, 75% water, 20% protein and in remaining part glycogen, creatine phosphate, inorganic ions (K^+, Na^+, HCO_3^-) are present.

Disorders of Muscular System

1. **Myasthenia Gravis:** Auto immune disorder affecting neuromuscular junction leading to fatigue, weakening and paralysis of skeletal muscle.
2. **Muscular Dystrophy:** Progressive degeneration of skeletal muscle mostly due to genetic disorder.
3. **Tetany:** Rapid spasms (wild contractions) in muscle due to low Ca^{++} in body fluid.

Golden Key Points

1. Muscles make up 40-50% of your total body weight.
2. Smallest muscles is found in the middle ear (Stapedius).
3. Humans are born with all the muscle fibres that they will ever have.
4. In Human beings **639** muscle are found. **400** muscles are striated & most of the muscles are found in back region & number of back muscles are **180**. *Longest smooth muscle is present in uterus of pregnant lady*.
5. **Cori cycles :** Lactic acid is accumulated in muscles during sustained contraction. This formed lactic acid is transported in blood as blood lactate to liver where it changes into liver glycogen which is further changed in to glucose.



Exercise - I

1. __A__ band contains actin and is called __B__ band, whereas the __C__ band called __D__band contains myosin.
Choose the correct options for A, B and C.
(1) A-Light, B-I, C-dark, D-A
(2) A-Dark, B-I, C-light, D-A
(3) A-Dark, B-A, C-light, D-I
(4) A-Light, B-A, C-dark, D-I

2. A sarcomere in the myofibrils of muscle is found in between :
(1) 2 M-lines (2) 2 Z-lines
(3) 2 H-zones (4) 2 A-bands

3. Contractile unit of muscle fibres :
(1) Muscle fibre (2) Sarcomere
(3) Myofibril (4) Sarcosom

4. Epimysium of muscles are made up of :
(1) White fibrous connective tissue
(2) Adipose connective tissue
(3) Reticular connective tissue
(4) Areolar connective tissue

5. Contraction of skeletal muscle is initiated by binding of calcium to :
(1) Troponin (2) Tropomyosin
(3) Myosin (4) Actin

6. ATPase activity found in :
(1) Myosin filament (2) Actin filament
(3) Tropomyosin (4) Troponin

7. Cardiac muscles Fibres are :
(1) Involuntary (3) Striated like
(2) Non-fatigue (4) All

8. Striated muscle fibres found in :
(1) Trachea (2) Leg
(3) Lung (4) Gall bladder

9. Smooth muscles fibres are :
(1) Spindle shaped
(2) Unbranched & Involuntary
(3) Uninucleated
(4) All of above

10. Which muscle is primarily involved in locomotory action and changes in body posture ?
(1) Stripped muscles
(2) Voluntary muscles
(3) Skeletal muscles
(4) All

11. The type of muscles present in our :
(1) Upper arm are smooth muscle fibres fusiform in shape.
(2) Heart are involuntary and unstriated smooth muscles.
(3) Intestine are striated and involuntary.
(4) Thigh are striated and voluntary.

12. During contraction of muscles :
(1) Actin Filament slide over actin
(2) Myosin filament slide over actin
(3) Actin filament slide over myosin
(4) Myosin filament slide over actin

13. Mitochondria in cardiac muscles :
(1) More than other muscles fibres
(2) Less than other muscles fibres
(3) Equal than other muscles fibres
(4) None

14. Which one of the following is ***correct*** pairing of a body part and the kind of muscle tissue that moves it ?
(1) Iris – Involuntary smooth muscle
(2) Heart wall – Involuntary unstriated muscle
(3) Biceps of upper arm – Smooth muscle fibres
(4) Abdominal wall – Smooth muscle

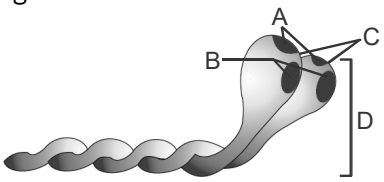
15. Identify from the following list, the characteristics of red muscle (A) and white muscles (B) and select the option that correctly segregates the characters.
(i) Less number of mitochondria
(ii) More number of mitochondria
(iii) Sarcoplasmic reticulum is abundant
(iv) Myoglobin content high
(v) Sarcoplasmic reticulum moderate
(vi) Aerobic muscles
(vii) Depend on anaerobic respiration for energy
(viii) Less myoglobin content

	A	**B**
(1)	(i), (iii), (vii), (viii)	(ii), (iv), (v), (vi)
(2)	(ii), (iv), (v), (vi)	(i), (iii), (vii), (viii)
(3)	(i), (iii), (iv), (vii)	(ii), (v), (vi), (viii)
(4)	(ii), (v), (vi), (viii)	(i), (iii), (iv), (vii)

16. Immediate source of energy for muscle contraction is :
(1) Glucose
(2) GTP
(3) ATP
(4) Creatine phosphate

17. Rigor mortis is :
(1) Contraction of muscles after death
(2) Contraction of muscles before death
(3) Shivering of muscles
(4) None

18. Identify A, B, C and D in the given diagram and choose the correct option.



(1) A–Actin binding site, B–ATP binding site, C–Head, D-Cross arm
(2) A–Actin binding site, B–ATP binding site, C–Head, D-Side arm
(3) A–Actin binding site, B–ATP binding site, C–Head, D-Long arm
(4) A–Actin binding site, B–ATP binding site, C–Head, D-Short arm

19. The muscle fatigue occurs due to accumulation of :
(1) CO_2
(2) Lactic acid
(3) Creatine phosphate
(4) Myosin ATPase

20. Globular head of meromyosin contains -
(1) ATPase enzyme
(2) Binding site for ATP
(3) Active site for actin
(4) All of these

21. Least blood supply will be present in :
(1) Skeletal muscle (2) Cardiac muscle
(3) Smooth muscle (4) All of the above

22. Which of the following is **incorrect** w.r.t. skeletal muscle fibre ?
(1) Multinucleated muscle fibre
(2) Sarcoplasmic reticulum is store house of calcium ions
(3) Control by CNS & ANS
(4) Striated appearance of the myofibril is due to distribution of two important proteins-actins and myosin.

23. Chemical Ions responsible for ATPase activity of myosin head **:**
(1) Ca^{++} & K^{+} (2) Na^{+} & K^{+}
(3) Na^{+} & Ca^{++} (4) Ca^{++} & Mg^{++} ions

24. Actin binding sites are found on :-
(1) Actin protein (2) Tropomyosin
(3) Myosin (4) Troponin

25. Which points are not correct about red fibers :-
(i) More myoglobin
(ii) More mitochondria
(iii) More sarcoplasmic reticulum
(iv) Depend on anaerobic process for energy
(v) Gives a reddish appearance.
(1) (i), (ii) (2) (iii), (iv)
(3) (ii), (iii) (4) (iv), (v)

26. The depolarisation of muscle fibre starts with opening of channels present on sarcolemma which are related with ?
(1) Mg^{+2} ion (2) Ca^{+2} ion
(3) Na^{+} ion (4) Ca^{+2} and Mg^{+2}

27. Find out **incorrect** statement :
(1) All locomotions are movement, but all movements are not locomotions
(2) Red muscle fibers having more mitochondria and myoglobin
(3) Skeletal muscles are voluntary and striated
(4) Cardiac muscles are unstriated, branched and involuntary.

28. Store house of calcium in muscle is ?
(1) Sarcomere
(2) Sacrosome
(3) Sarcoplasmic reticulum
(4) Lysosome

29. Match column I with column II and select the best option :

	Column-I	**Column-II**
(1)	Paramoecium	Tentacles
(2)	Skeletal muscle	Alimentary canal
(3)	Macrophage	Ammoeboid movement
(4)	Leucocytes	Ciliary movement

30. Read the following statements carefully and choose the option giving incorrect description :

(1) Cardiac muscles are involuntary is nature as the nervous system does not control their activities directly

(2) Muscle fibre is a syncitium as the sarcoplasm contains single nucleus.

(3) Each myofibril has alternate light and dark bands on it due to distribution pattern of two important proteins - Actin and Myosin.

(4) Functional unit of contraction of skeletal muscle is called a sarcomere.

31. In the resting state, a subunit of ____ masks the active binding sites for ____ on actin filaments :

(1) Myosin, Actin

(2) Troponin, Myosin

(3) Actin, Tropomyosin

(4) Myosin, Troponin

32. During the shortening of muscle i.e. contraction, the ___ gets reduced whereas ___ do not change:

(1) I-band, A -band (2) H-band, I-band

(3) I-band, Z-disc (4) A-band, I-band

33. During the process of relaxation of muscle, which of the following ions are pumped back to sarcoplasmic cisternae ?

(1) Na^+ (2) Ca^{++} and Na^+

(3) $Mg^+$and Ca^{+2} (4) Ca^{++}

34. Each organised skeletal muscle is made up of number of muscle bundles held together by :-

(1) Perimysium (2) Fascia

(3) Endomysium (4) Endoneurium

35. The muscles involved in the movements of gametes through genital tract and locomotory actions are respectively :-

(1) Cardiac and skeletal

(2) Smooth and skeletal

(3) Skeletal and unstriated

(4) Unstriated only

36. How many statements are not incorrect -

I. Meromyosin composed of HMM and LMM

II. In red fibres less quantity of myoglobin present so they are known as aerobic fibres

III. Muscles contraction is initiated by a signal sent by the central nervous system via a sensory neuron.

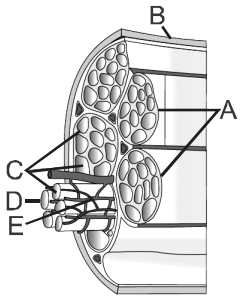
IV. Locomotion requires a perfect coordination activity of muscular, skeletal system and Nervous system.

V. About 40-50 percent of the body weight of a human adult is contributed by muscles.

(1) One (2) Two

(3) Three (4) Four

37. Which of the following is correctly define the diagram -



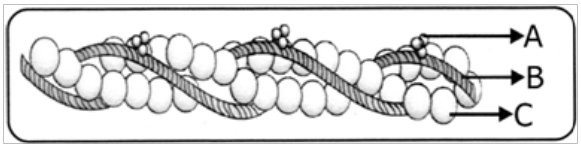
(1) A-Endomysium, B-Perimysium

(2) A-Endomysium, B-Sarcolemma

(3) B-Epimysium, C-Muscle fibre

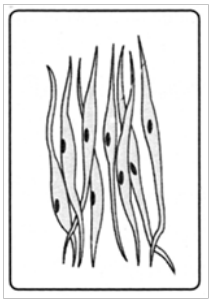
(4) D-Perimysium, E-Muscle bundle

38. Label the different components of actin filament in the diagram given below.



	A	B	C
(1)	Troponin	G-actin	Tropomyosin
(2)	Tropomyosin	Troponin	F-actin
(3)	Troponin	F-actin	Myosin
(4)	Troponin	Tropomyosin	F-actin

39. Find the correct option related to given type of muscles in given diagram.



(i) Spindle shaped
(ii) Striated
(iii) Cell junction present
(iv) Involuntary
(v) Found in arm and wall of intestine
(1) Only I, iii, iv and v are correct
(2) Only I, iii and iv are correct
(3) Only I, iv and v are correct
(4) Only ii and iii are correct

40. The difference between a white and red fibre in skeletal muscle can be based on all except :

(1) Amount of oxygen store
(2) Number of mitochondria
(3) Presence of sarcomeres
(4) Presence of sarcoplasmic reticulum

41. Progressive degeneration of skeletal muscle mostly due to genetic disorder is :
(1) Muscular dystrophy (2) Tetany
(3) Myasthenia gravis (4) Gout

42. The part which disappear on maximum contraction of muscle :-
(1) Anisotropic band (2) Z-line
(3) Hensen's zone (4) All of the above

43. In Meromyosin, the globular head is :
(A) A component of heavy meromyosin
(B) An active ATPase enzyme
(C) Having binding sites for ATP
(D) Having active sites for actin
(E) Component of light meromyosin only
(1) A, B & C (2) A, B, C & D
(3) B, C, D & E (4) B, C & d

44. In the centre of each 'I' band is an elastic fibre which bisect is It is known as :-
(1) Z-line (2) H-Zone
(3) M-line (4) Titin

45. Each F-actin is also a polymer of monomeric G- actins. Two filaments of another protein, ____also run close to the F-actins throughout its length is :
(1) Troposin (2) Actinin
(3) Tropomyosin (4) Myomesin

ANSWER-KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ans.	1	2	2	1	1	1	4	2	4	4	4	3	1	1	2	3	1	1	2	4	3	3	4	3	2
Que.	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**					
Ans.	3	4	3	3	2	2	1	4	2	2	3	3	4	2	3	1	3	2	1	3					

Exercise - II

1. Striated muscles are primarily involved in :
(A) Locomotory actions
(B) Changes in body postures
(C) Transportation of food through digestive tract
(D) Transportation of gametes through genital tract
(1) A, B (2) B, C (3) C, D (4) A, D

2. Which character is/are associated with locomotion ?
(A) All locomotion are movements
(B) All movements are not locomotions
(C) Methods of locomotion vary with animals habitats
(D) Locomotion is also for escape from predators
(1) A and B (2) B, C and D
(3) A, B and C (4) A, B, C and D

3. Motor neuron along with muscle fibers are connected & constitute a :
(1) Neuro muscular junction
(2) Motor end plate
(3) Motor unit
(4) Both (1) & (2)

4. Intercalated disc & oblique bridges are only present in :
(1) Skeletal muscle (2) smooth muscle
(3) Cardiac muscle (4) Visceral muscle

5. Muscles contains a red coloured oxygen storing pigment called :
(1) Haemoglobin (2) Sarcosome
(3) Myoglobin (4) Haemocyanine

6. The thick filaments in 'A' band are held together in the middle of this band by a thin membrane called :
(1) Z-line (2) M-line
(3) H-line (4) O-line

7. A neural signal reaching neuromuscular junction releases a neurotransmitter commonly :
(1) Dopamine (2) Acetylcholine
(3) GABA (4) Glycine

8. In a resting state, the central part of thick filament which is not overlappled by thin filament is called:
(1) A-band (2) M-line
(3) H-zone (4) I-band

9. Myosin head contains :
(1) ATPase
(2) ATP binding sites
(3) Active sites for actin
(4) All of these

10. The junction between a motor neuron and the sarcolemma of a muscle fibre is :
(1) Neuro muscular junction
(2) Motor end plate
(3) Gap junction
(4) Both 1 and 2

11. Which points are correct for cardiac muscles ?
(A) They are striated
(B) They are unbranched
(C) They are involuntary
(D) Intercalacted disc are present
(1) A, B, C (2) B, C, D
(3) A, C, D (4) A, B, D

12. Which character is not associated with white muscle fibres ?
(1) Less quantity of myoglobin.
(2) Number of mitochondria are few.
(3) Amount of sarcoplasmic reticulum is low.
(4) Depend on anaerobic process for energy.

13. Which points are correct about visceral muscles?
(1) These are located in the inner walls of hollow visceral organs of the body.
(2) They do not exhibit any striations.
(3) Their activities are not under the voluntary control of the *nervous* system.
(4) All of the *above*

14. The body weight contributed by muscles in a human adult is :
(1) 30-40% (2) 40-50%
(3) 50-60% (4) 60-70%

15. In paramoecium, the movement of food through cytopharynx take place by :
(1) Cilia (2) Flagella
(3) Microvilli (4) Myonemes

16. The striated appearance of the myofibril is due to the distribution pattern of :
(1) Actin (2) Myosin
(3) Tropomyosin (4) Both 1 and 2

17. Which points are correct with the regarding of skeletal muscles?
(A) Their activities are under the *voluntary* conrol of the *nervous* system.
(B) They are located in the inner walls of visceral organs.
(C) They are primarily *involved* in locomotory actions and changes of body postures.
(D) They *have* no striped appearance
(1) B, D (2) B, C (3) A,D (4) A, C

18. Correctly match column-I with column-II.

	Column-I		**Column-II**
(A)	Tetany	(i)	Auto immune disorder.
(B)	Osteoporosis	(ii)	Progressive degeneration of skeletal muscle.
(C)	Muscular dystrophy	(iii)	Inflammation of joints.
(D)	Arthritis	(iv)	Rapid spasms in muscle.
(E)	Myasthenia Gravis	(v)	Bone mass decreased.

(1) A→(i), B→(ii), C→(iii), D→(iv), E→(v)
(2) A→(iv), B→(v), C→(i), D→(iii), E→(ii)
(3) A→(iv), B→(v), C→(ii), D→(iii), E→(i)
(4) A→(ii), B→(iii), C→(i), D→(v), E→(iv)

19. The correct sequence of events during relaxation of muscle is :
(i) Masking of Actin filament
(ii) Ca^{++} returned to SR
(iii) Z-line back to their original positior
(1) (i), (ii), (iii) (2) (ii), (i), (iii)
(3) (ii), (iii), (i) (4) (iii), (ii), (i)

20. Ciliary movement is found in :
(1) Macrophages and leucocytes
(2) Fallopian tube and vasa deferentia
(3) Fallopian tube and Trachea
(4) Tongue and Limbs

21. Amoeboid movement is found in :
(1) Limbs, Jaw
(2) Macrophages, Leucocytes
(3) Trachea, Fallopian tube
(4) Tongue, Lencocytes

22. In the center of I-Band, is an elastic fiber, which bisect it
(1) 'H'-zone (2) 'M'-line
(3) 'Z' line (4) A-band

23. The ion that must be present for binding of the cross bridges between actin and myosin is :
(1) Sodium (2) Calcium
(3) Iron (4) Potassium

24. According to the established sliding filament model of muscle contraction, the molecules that move to shorten a muscle are :
(1) Myosin (2) Actin
(3) Troponin (4) All of these

25. The all or none phenomenon of muscle contraction refers to a maximum contraction or no contraction of a
(1) Muscle fibre (2) Muscle bundle
(3) Muscle fibril (4) Muscle

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ans.	1	4	3	3	3	2	2	3	4	4	3	3	4	2	1	4	4	3	2	3	2	3	2	2	1

Exercise – III (Previous Year Question)

[AIPMT Mains 2011]

1. The type of muscles present in our :
(1) Upper arm are smooth muscle fibres fusiform in shape.
(2) Heart are involuntary and unstriated smooth muscles.
(3) Intestine are striated and involuntary.
(4) Thigh are striated and voluntary.

[AIPMT Mains 2012]

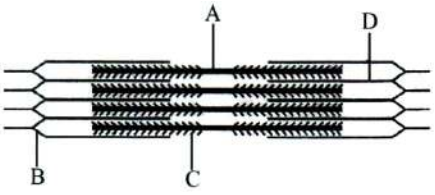
2. Which one of the following pairs of chemical substances, is correctly categorized ?
(1) Troponin and myosin – Complex proteins in striated muscles
(2) Secretin and rhodopsin – Polypeptide hormones
(3) Calcitonin and thymosin – Thyroid hormones
(4) Pepsin and prolactin – Two digestive enzymes secreted in stomach

[NEET 2013]

3. The H-zone in the skeletal muscle fibre is due to
(1) Extension of myosin filaments in the central portion of the A-band.
(2) The absence of myofibrils in the central portion of A-band.
(3) The central gap between myosin filaments in the A-band.
(4) The central gap between actin filaments extending through myosin filaments in the A-band.

[AIIMS 2013]

4.



Choose the correct one for given diagram :
(1) B ⇒ Z-Line - Provide attachment to actin
(2) A ⇒ A-Band - During contraction get reduced
(3) C ⇒ Troponin - Pulls the actin filament/ thin filament
(4) D ⇒ Myosin - Thin filament

[AIPMT 2014]

5. Stimulation of a muscle fiber by a motor neuron occurs at :
(1) The neuromuscular junction
(2) The transverse tubules
(3) The myofibril
(4) The sacroplasmic reticulum

[AIPMT 2015]

6. Sliding filament theory can be best explained as :
(1) Actin and Myosin filaments shorten and slide pass each other
(2) Actin and Myosin filaments do not shorten but rather slide pass each other
(3) When myofilaments slide pass each other, Myosin filaments shorten while Actin filaments do not shorten
(4) When myofilaments slide pass each other Actin filaments shorten while Myosin filament do not shorten.

[NEET 2016]

7. Name the ion responsible for unmasking of active sites for myosin for cross-bridge activity during muscle contraction :
(1) Calcium (2) Magnesium
(3) Sodium (4) Potassium

8. Lack of relaxation between successive stimuli in sustained muscle contraction is known as :
(1) Tetanus (2) Tonus
(3) Spasm (4) Fatigue

[NEET 2018]

9. Calcium is important in skeletal muscle contraction because it :
(1) Prevents the formation of bonds between the myosin cross bridges and the actin filament.
(2) Binds to troponin to remove the masking of active sites on actin for myosin.
(3) Detaches the myosin head from the actin filament.
(4) Activates the myosin ATPase by binding to it.

[NEET 2019]

10. Which of the following muscular disorders is inherited ?

(1) Myasthenia gravis

(2) Botulism

(3) Tetany

(4) Muscular dystrophy

[NEET 2020 (Covid-19)]

11. Match the following columns and select the correct option.

	Column-I		**Column-II**
(a)	Gout	(i)	Decreased levels of estrogen
(b)	Osteoporosis	(ii)	Low Ca^{++} ions in the blood
(c)	Tetany	(iii)	Accumulation of uric acid crystals
(d)	Muscular dystrophy	(iv)	Auto immune disorder
		(v)	Genetic disorder

(1) (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)

(2) (a)-(iii), (b)-(i), (c)-(ii), (d)-(v)

(3) (a)-(iv), (b)-(v), (c)-(i), (d)-(ii)

(4) (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)

[NEET 2021]

12. Which of the following statements wrongly represents the nature of smooth muscle?

(1) These muscle have no striations

(2) They are involuntary muscles

(3) Communication among the cells is performed by intercalated discs

(4) These muscles are present in the wall of blood vessels

13. During muscular contraction which of the following events occur ?

(a) 'H' zone disappears

(b) 'A' band widens

(c) 'I' band reduces in width

(d) Myosin hydrolyzes ATP, releasing the ADP and Pi

(e) Z-lines attached to actins are pulled inwards

Choose the **correct** answer from the options given below.

(1) (a), (c), (d), (e) only

(2) (a), (b), (c), (d) only

(3) (b), (c) (d), (e) only

(4) (b), (d), (e), (a) only

[RE-NEET 2022]

14. According to the sliding filament theory:-

(1) Actin and myosin filaments side over each other to increase the length of the sarcomere.

(2) Length of A-band does not change

(3) I-band increases in length

(4) The actin filaments slide away from A-band resulting in shortening of sarcomere.

15. Choose the **correct** statements about a muscular tissue:-

(1) Skeletal muscle fibres are uninucleated and found in parallel bundles

(2) Intercalated discs allow the cardiac muscle cells to contract as a unit.

(3) The walls of blood vessels are made up of columnar epithelium.

(4) Smooth muscles are multinucleated and involuntary.

ANSWER KEY

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Ans.	4	1	4	1	1	2	1	1	2	4	2	3	1	2	2