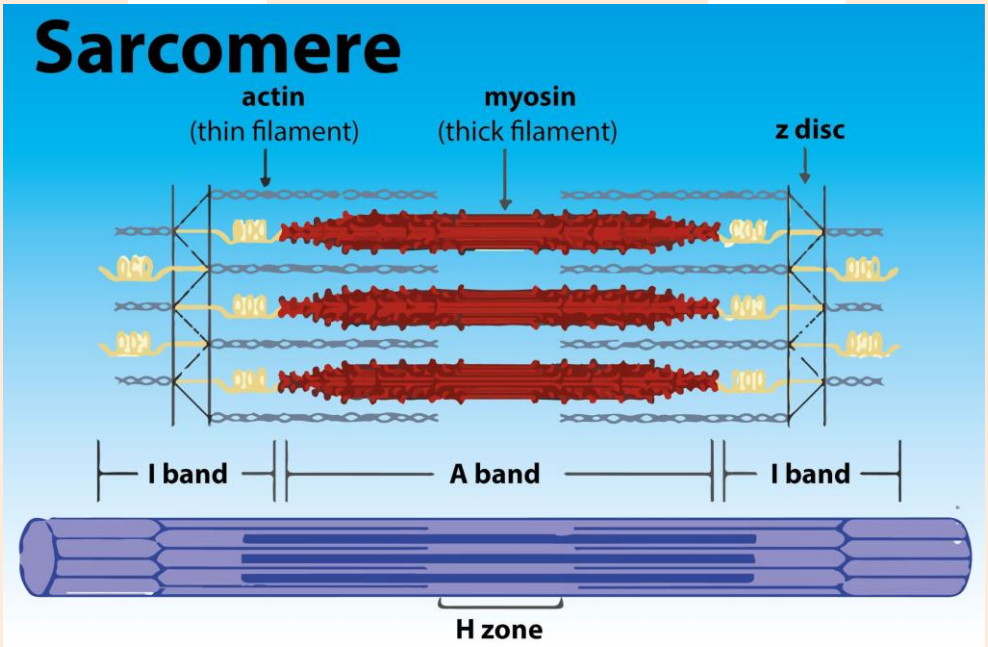
NCERT Solutions for Class 11

Biology

Chapter 20 - Locomotion and Movement

1. Draw the diagram of a sarcomere of skeletal muscle showing different regions.

Ans: The diagrammatic representation of a sarcomere is as follows:

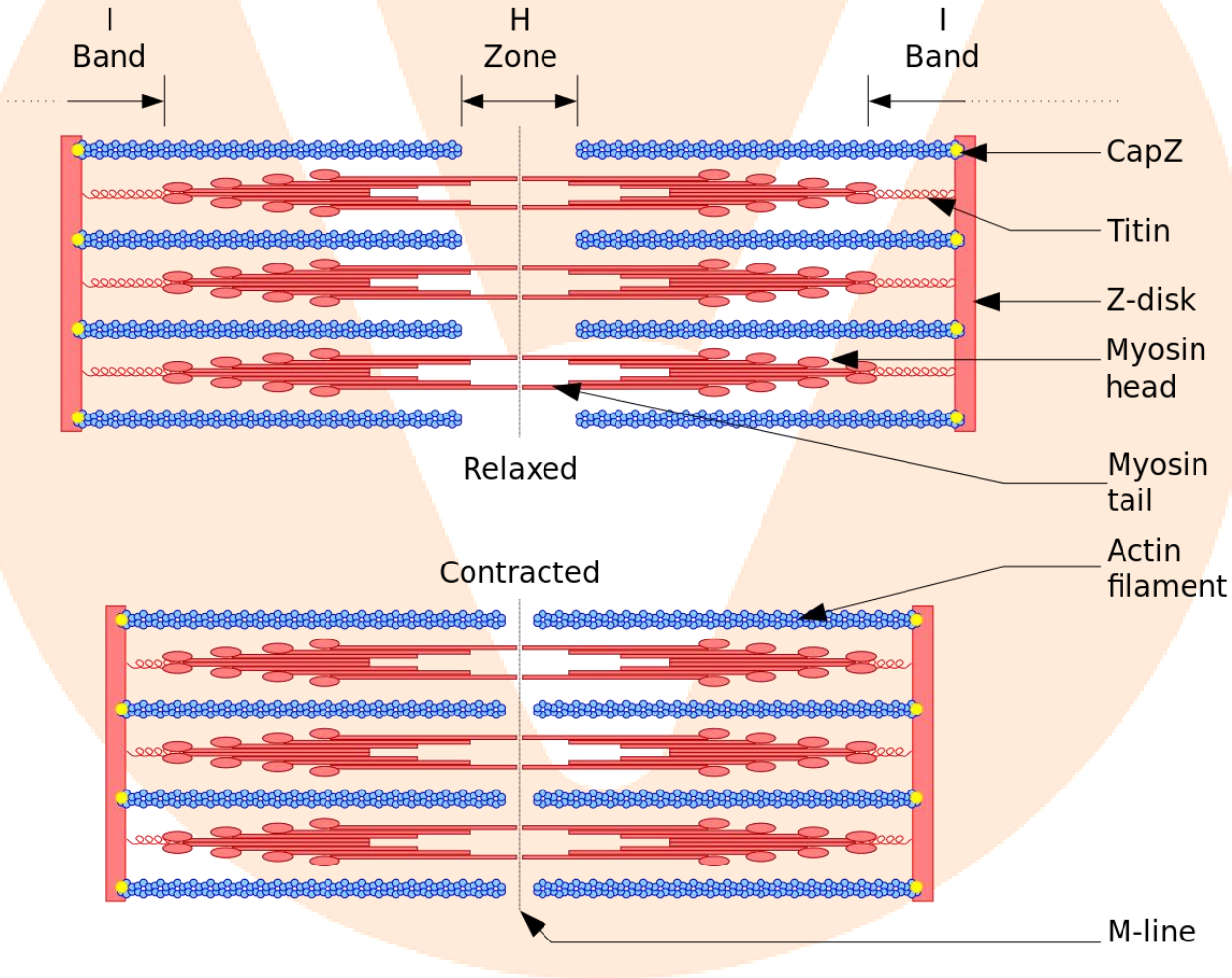


2. Define the sliding filament theory of muscle contraction.

Ans: The sliding filament theory describes the process of muscle contraction in which the thick filaments (myosin) of muscle fibres slide past the thin filaments (actin), resulting in the shortening of the myofibril. Each muscle fibre consists of alternate light and dark bands. They contain a unique contractile protein called actin and myosin respectively. Myosin is a thick contractile protein found in the dark band and is known as the A-band or Anisotropic band. Actin is a thin contractile protein found in the light band and is known as the I-band or Isotropic band. Each I-band is

bisected by an elastic fibre known as the Z line. The thin filament (actin) is firmly attached to the Z line. The H-zone is the central portion of the thick filament (myosin) that is not overlapped by the thin filament. Sarcomere, the functional unit of contraction, is the portion of the myofibril between two successive Z lines.

During muscle contraction, the myosin heads come into close contact with the thin filaments. As a result, the thin filaments are pulled towards the centre of the sarcomere as well as the Z line attached to the actin filaments is also pulled, causing shortening of the sarcomere. The length of the A-band or anisotropic band remains constant as its original length whereas the I-band or isotropic band shortens and the H-zone disappears.



3. Describe the important steps in muscle contraction.

Ans: During skeletal muscle contraction, the thick filament slides past the thin filament (actin) via repeated binding, releasing myosin along the filament. This entire process takes place in sequential order.

(i) Step 1: Muscle contraction is initiated by a signal that is sent by a CNS (Central nervous system) through a motor neuron. A neuromuscular junction or motor-end plate is a junction between a motor neuron and the sarcolemma of the muscle fibre. When a signal reaches the neuromuscular junctions, Acetylcholine (a neurotransmitter) is released which results in the generation of an action potential in the sarcolemma.

(ii) Step 2: This spreads through the muscle fibres, resulting in the release of calcium ions from the sarcoplasmic reticulum into the sarcoplasm.

(iii) Step 3: The increased calcium ions (Ca^{2+}) in the sarcoplasm leads to the activation of actin sites. Calcium ions (Ca^{2+}) bind with the subunit of troponin on actin filaments and thus remove the masking of active sites for myosin. Hence, active sites on actin are exposed and this allows myosin heads to attach to this site.

(iv) Step 4: The myosin head now attaches to the exposed site of actin to form a cross-bridge by utilizing energy from ATP hydrolysis. The actin filaments are pulled towards the centre of the A-band. The Z line attached to the actin filaments is also pulled, causing shortening of the sarcomere, i.e., the contraction of the muscle occurs. It is clear from the above steps, that during contraction, the length of the A-band or anisotropic band remains constant as its original length whereas the I-band or isotropic band gets reduced.

(v) Step 5: After muscle contraction, the myosin head goes back to its relaxed state, releasing ADP and inorganic phosphate (Pi). A new ATP molecule binds and detaches myosin, thus the cross-bridges are broken.

(vi) Step 6: This process of formation and breaking down is repeated causing further sliding. This process continues until the calcium ions are pumped back to the sarcoplasmic cisternae. Hence, the calcium ions concentration decreases. This results in masking the actin filaments and leading to muscle relaxation.

4. Write true or false. If false, change the statement so that it is true.

(a) Actin is present in the thin filament.

Ans: True

(b) H-zone of striated muscle fibre represents both thick and thin filaments.

Ans: False. The H-zone of striated muscle fibre represents only a thick filament.

(c) Human skeleton has 206 bones.

Ans: True

(d) There are 11 pairs of ribs in man.

Ans: False. There are 12 pairs of ribs in a man.

(e) Sternum is present on the ventral side of the body.

Ans: True

5. Write the difference between:

(a) Actin and Myosin

Ans: The difference between Actin and Myosin are: -

	Actin	**Myosin**
(i)	Actin is a thin contractile protein.	Myosin is a thick contractile protein.
(ii)	It is present in the light bands and is called an I-band or isotropic band.	It is present in the dark bands and is called an A-band or anisotropic band.
(iii)	It has a smooth surface.	It has a rough surface.
(iv)	It does not form cross-bridges.	It forms cross-bridges.
(v)	It consists of troponin and tropomyosin.	It consists of meromyosin (myosin monomer).

(b) Red and White muscles

Ans: The difference between red and white muscle fibres are: -

	Red Muscle Fibre	**White Muscle Fibre**
(i)	Red muscle fibres are thinner and smaller than white muscle fibres.	White muscle fibres are thicker and larger than red muscle fibres.
(ii)	They are red in colour because they possess large amounts of myoglobin.	They are white in colour because they possess small amounts of myoglobin.
(iii)	They have mitochondria in large numbers.	They have a comparatively smaller number of mitochondria.
(iv)	They carry out a slow rate of contractions for a long period.	They carry out a fast rate of contraction for a short duration.
(v)	They provide energy by performing aerobic respiration.	They provide energy by performing anaerobic respiration

(c) Pectoral and Pelvic girdle

Ans: The difference between pectoral and pelvic girdles are: -

	Pectoral Girdle	**Pelvic Girdle**
(i)	The pectoral girdle is situated in the shoulder (pectoral region).	The pelvic girdle is situated in the hip (pelvic region).
(ii)	It is composed of two bones: - Clavicle or collar bones and scapula or shoulder bone.	It is composed of three bones: - the upper ileum, inner pubic, and ischium.
(iii)	It helps in the articulation of upper limbs.	It helps in the articulation of lower limbs.

(iv)	It performs functions like lifting, holding etc.	It performs functions like walking, standing, jumping, running etc.

6. Match Column I with Column II:

	Column I		**Column II**
(a)	**Smooth Muscle**	**(i)**	**Myoglobin**
(b)	**Tropomyosin**	**(ii)**	**Thin Filament**
(c)	**Red muscle**	**(iii)**	**Sutures**
(d)	**Skull**	**(iv)**	**Involuntary**

Ans:

	Column I		Column II
(a)	Smooth Muscle	(iv)	Involuntary
(b)	Tropomyosin	(ii)	Thin filament
(c)	Red muscle	(i)	Myoglobin
(d)	Skull	(iii)	Sutures

7. What are the different types of movements exhibited by the cells of the human body?

Ans: Movement is a characteristic property of all living organisms. Cells in the human body exhibit various types of movement, which are as follows:

(i) Amoeboid movement: This type of movement is exhibited by some specialised cells like leucocytes (White blood cells) and macrophages (immune cells) present in the blood. These blood cells move from the circulatory system to the injury site during tissue damage to initiate an immune response.

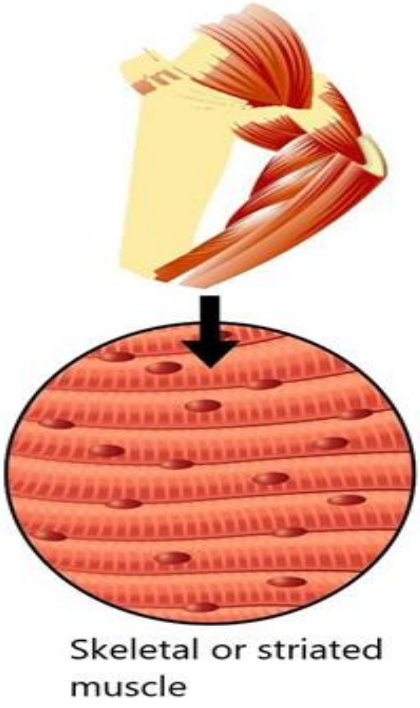
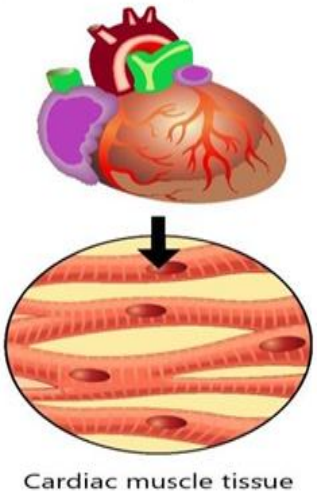
(ii) Ciliary movement: This type of movement is exhibited by reproductive cells such as sperms and ova. Ciliary movement facilitates the passage of the ova through the fallopian tube towards the uterus.

(iii) Muscular movement: This type of movement is exhibited by muscle cells which are caused by the contraction of the myofibril of the muscle cells.

8. How do you distinguish between a skeletal muscle and a cardiac muscle?

Ans: The difference between a skeletal muscle and a cardiac muscle are:

	Skeletal Muscle	**Cardiac Muscle**
(i)	Skeletal muscles are attached to the bones and skins.	The heart is the only organ with cardiac muscles.
(ii)	They are voluntary muscles as their activities are under the voluntary control of the nervous system.	They are involuntary muscles as their activities are not directly controlled by the nervous system. They are controlled by the central nervous system, endocrine system and different chemicals.
(iii)	The cells of the skeletal muscles are straight, cylindrical, non-branched and multinucleated.	The cells of the cardiac muscles are cylindrical, branched and uni-nucleated.
(iv)	They do not have intercalated discs.	Intercalated discs connect the cells and aid in the coordination or synchronization of the heartbeat.
(v)	They have a high energy requirement.	They have an intermediate energy requirement.

(vi)	They contract rapidly and are fatigued easily in a short period of time.	They contract rapidly but do not fatigue easily.
(vii)	They help in movement and locomotion.	They help in the contraction and relaxation of the heart.
(viii)	 Skeletal or striated muscle	 Cardiac muscle tissue

9. Name the type of joint between the following:

(a) Atlas/axis

Ans: Pivot joint is present in between atlas and axis.

(b) carpal/metacarpal of the thumb

Ans: The saddle joint is located between the carpal and metacarpal of the thumb.

(c) between phalanges

Ans: Hinge joint is present in between phalanges.

(d) femur/acetabulum

Ans: Ball and socket joint is present in between the head of femur and acetabulum.

(e) between cranial bones

Ans: between cranial bones: Fibrous joint is present in between cranial bones.

(f) between pubic bones in the pelvic girdle

Ans: between pubic bones in the pelvic girdle: Ball and socket joint is present in between pubic bones in the pelvic girdle.

10. Fill in the blank spaces:

(a) All mammals (except a few) have _____ cervical vertebrae.

(b) The number of phalanges in each limb of a human is _____.

(c) Thin filament of myofibril contains 2 'F' actins and two other proteins namely _____ and _____.

(d) In a muscle fibre (Ca^{2+}) is stored in _____.

(e) _____ and _____ pairs of ribs are called floating ribs.

(f) The human cranium is made of _____ bones.

Ans:

(a) All mammals (except a few) have seven cervical vertebrae.

(b) The number of phalanges in each limb of a human is 14.

(c) The thin filament of myofibril contains 2 'F' actins and two other proteins namely troponin and myosin.

(d) In a muscle fibre (Ca^{2+}) is stored in the sarcoplasmic reticulum.

(e) 11^{th} and 12^{th} pairs of ribs are called floating ribs.

(f) The human cranium is made of eight bones.