Exercise Questions

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

Solution:

The figure below represents the sarcomere of skeletal muscle showing different regions:

2. Define sliding filament theory of muscle contraction.

Solution:

Sliding filament theory can be defined as a theory which states that the contraction of a muscle fibre occurs due to the sliding of the thin filaments over thick filaments.

3. Describe the important steps in muscle contraction.

Solution:

The mechanism of muscle contraction is best explained by the sliding filament theory which states that the contraction of a muscle fibre occurs due to the sliding of the thin filaments over the thick filaments.
Mechanism of muscle contraction:

Step 1: Sarcolemma depolarizes
- The central nervous system (CNS) sends a signal through a motor neuron that arrives at the motor end plate or the neuromuscular junction.
- The neuromuscular junction is the junction present between the sarcolemma of the muscle fiber and the motor neuron.
- The signal that arrives at the neuromuscular junction triggers the release of a neurotransmitter known as acetylcholine. This release sets the action potential in the sarcolemma.
Step 2 : Calcium ions are released
- The action potential is transmitted by the sarcolemma to the sarcoplasmic reticulum in order to release the calcium ions in the sarcoplasm

Step 3 : Actin filaments is subjected to conformational changes
- The calcium ions that are released, tends to bind to the tropomyosin and troponin located on the active filaments
- The linkage causes a modification in the three-dimensional structure of the actin-troponin-tropomyosin complex. The active site for myosin located on the actin filament is exposed.

Step 4 : Myosin heads are activated
- The release of the calcium ions causes the myosin heads to get activated which inturn causes the release of energy in the form of ATP
- Hydrolysis of ATP releases energy that causes the binding of myosin heads to the active sites found on the actin filaments thereby forming a cross-bridge

Step 5 : Actin Filaments slide over Myosin
- Formation of cross-bridge causes the myosin head to rotate, pulling the actin filaments to the centre of the A-band which is the H-zone
- The z-line that is attached to the actin filaments is pulled inwards too
- The sarcomere contracts when the actin filaments are pulled in the opposite ends
- The I-band shortens during the process of contraction whereas the A-band maintains its length causing the muscles to contract.

4. Write true or false. If false change the statement so that it is true.
(a) Actin is present in thin filament
(b) H-zone of striated muscle fibre represents both thick and thin filaments.
(c) Human skeleton has 206 bones.
(d) There are 11 pairs of ribs in man.
(e) Sternum is present on the ventral side of the body.

Solution:
(a) Actin is present in thin filament – True
(b) H-zone of striated muscle fibre represents both thick and thin filaments – False
   Corrected statement: H-zone of the striated muscle fiber represents only thick filaments
(c) Human skeleton has 206 bones - True
(d) There are 11 pairs of ribs in man – False
   Corrected statement: There are 12 pairs of ribs in man.
(e) Sternum is present on the ventral side of the body - True

5. Write the difference between:
(a) Actin and Myosin
(b) Red and White muscles
(c) Pectoral and Pelvic girdle

Solution:
The differences are as follows:

(a) Actin and myosin

<table>
<thead>
<tr>
<th>Actin</th>
<th>Myosin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forms thin filaments (I-bands) of the myofilament</td>
<td>Forms thick filaments (A-bands) of the myofilament</td>
</tr>
<tr>
<td>Built of globular actin monomers</td>
<td>Built of meromyosin monomers</td>
</tr>
<tr>
<td>Troponin and tropomyosin – the regulatory proteins, are linked with the actin</td>
<td>The regulatory proteins are not linked, instead each of the meromyosin is built of four light chains and two identical heavy chains</td>
</tr>
</tbody>
</table>

(b) Red and white muscles

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Red muscles</th>
<th>White muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myoglobin content</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Amount of sarcoplasmic reticulum</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Fibers</td>
<td>Narrow and thin</td>
<td>Broad and thick</td>
</tr>
<tr>
<td>Mitochondria</td>
<td>Possess many</td>
<td>Few</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Not fatigued</td>
<td>Fatigued</td>
</tr>
<tr>
<td>Type of respiration from which energy is derived</td>
<td>Aerobic</td>
<td>Anaerobic</td>
</tr>
</tbody>
</table>

(c) Pectoral and Pelvic girdle

<table>
<thead>
<tr>
<th>Pectoral girdle</th>
<th>Pelvic girdle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pectoral girdle is also known as the shoulder girdle</td>
<td>Pelvic girdle is also known as the hip girdle</td>
</tr>
<tr>
<td>Each part/half of the girdle consists of two bones – clavicle and scapula</td>
<td>Each part/half of the girdle consists of three bones – ischium, ilium and pubis</td>
</tr>
<tr>
<td>It offers forelimb articulation</td>
<td>It offers hindlimb articulation</td>
</tr>
<tr>
<td>Head of the humerus articulates with the glenoid cavity of the pectoral girdle</td>
<td>Head of the femur articulates with the acetabulum of the pelvic girdle</td>
</tr>
</tbody>
</table>

6. Match Column I with Column II:

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Smooth muscle</td>
<td>(i) Myoglobin</td>
</tr>
<tr>
<td>(b) Tropomyosin</td>
<td>(ii) Thin filament</td>
</tr>
<tr>
<td>(c) Red muscle</td>
<td>(iii) Sutures</td>
</tr>
<tr>
<td>(d) Skull</td>
<td>(iv) Involuntary</td>
</tr>
</tbody>
</table>

Solution:

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Smooth muscle</td>
<td>(iv) Involuntary</td>
</tr>
</tbody>
</table>
7. What are the different types of movements exhibited by the cells of human body?

Solution:

Movement is one of the fundamental characteristics observed in the living entities. The different types of movements exhibited by the human body cells are as follows:

- **Amoeboid Movement** – The cells that exhibit this type of movement are leucocytes found in blood. Leucocytes from the circulatory system move towards the injury site when there is a damage to the tissue in order to initiate an immune response.
- **Muscular movement** – this type of movement is exhibited by muscle cells
- **Ciliary movement** – The type of cells that exhibit this type of movement are sex cells (sperms and ova). This movement facilitates the passage of ova via the fallopian tube on its way to the uterus.

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

Solution:

The differences between a skeletal muscle and a cardiac muscles is as follows:

<table>
<thead>
<tr>
<th>Skeletal muscle</th>
<th>Cardiac muscle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linked to the primary bones</td>
<td>Located in the walls of the heart</td>
</tr>
<tr>
<td>Voluntary in nature</td>
<td>Involuntary in nature</td>
</tr>
<tr>
<td>Nucleus is peripherally located</td>
<td>Nucleus is centrally located</td>
</tr>
<tr>
<td>The muscle fibers of the skeletal muscles are unbranched</td>
<td>The muscle fibers of the cardiac muscles are branched</td>
</tr>
<tr>
<td>Muscle fibers of the skeletal muscles do not show intercalated discs</td>
<td>Intercalated discs are found in the muscle fibers of the cardiac muscles</td>
</tr>
<tr>
<td>Bring about the locomotory actions of the body and maintains body posture</td>
<td>Responsible for the movement/motion of the heart</td>
</tr>
</tbody>
</table>

9. Name the type of joint between the following:

(a) atlas/axis
(b) carpal/metacarpal of thumb
(c) Between phalanges
(d) femur/acetabulum
(e) Between cranial bones
(f) Between pubic bones in the pelvic girdle
Solution:

The types of joints are as follows:

(a) atlas/axis – Pivot joint
(b) carpal/metacarpal of thumb – Saddle joint
(c) Between phalanges – Hinge joint
(d) femur/acetabulum – Ball and socket joint
(e) Between cranial bones – Fibrous joint
(f) Between pubic bones in the pelvic girdle – cartilaginous joint

10. Fill in the blank spaces:
(a) All mammals (except a few) have __________ cervical vertebra.
(b) The number of phalanges in each limb of human is __________
(c) Thin filament of myofibril contains 2 ‘F’ actins and two other proteins namely ____ and _____.
(d) In a muscle fibre Ca++ is stored in __________
(e) __________ and __________ pairs of ribs are called floating ribs.
(f) The human cranium is made of __________ bones

Solution:

(a) Seven
(b) Fourteen
(c) Troponin, tropomyosin
(d) Sarcoplasmic reticulum
(e) Eleventh, twelfth
(f) Eight