Chapter 16: Skeleton and Movement

EXERCISE [PAGES 213 - 214]

Exercise | Q 1. (A) | Page 213
Choose the correct option.

The functional unit of striated muscle is _____.

1. cross bridges
2. myofibril
3. **sarcomere**
4. z-band

SOLUTION

The functional unit of striated muscle is **sarcomere.**

Exercise | Q 1. (B) | Page 213
Choose the correct option.

A person slips from the staircase and breaks his ankle bone. Which bones are involved?

1. Carpals
2. **Tarsal**
3. Metacarpals
4. Metatarsals

SOLUTION

Tarsal

Exercise | Q 1. (C) | Page 213
Choose the correct option.

Muscle fatigue is due to accumulation of _____.

1. pyruvic acid
2. **lactic acid**
3. malic acid
4. succinic acid

SOLUTION

Muscle fatigue is due to accumulation of **lactic acid.**

Exercise | Q 1. (D) | Page 213
Choose the correct option.

Which one of the following is NOT antagonistic muscle pair?

1. Flexo-extensor
2. Adductor-abductor
3. Levator-depressor
4. **Sphinetro-suprinater**

SOLUTION

Sphinetro-suprinater

Exercise | Q 1. (E) | Page 213

Choose the correct option.

Swelling of sprained foot is reduced by soaking in hot water containing a large amount of common salt,

1. **due to osmosis**
2. due to plasmolysis
3. due to electrolysis
4. due to photolysis

SOLUTION

Swelling of sprained foot is reduced by soaking in hot water containing a large amount of common salt, **Due to osmosis.**

Exercise | Q 1. (F) | Page 213

Choose the correct option.

Role of calcium in muscle contraction is _____.

1. to break the cross-bridges as a cofactor in the hydrolysis of ATP
2. **to bind with troponin, changing its shape so that the actin filament is exposed**
3. to transmit the action potential across the neuromuscular junction.
4. to re-establish the polarisation of the plasma membrane following an action potential

SOLUTION

Role of calcium in muscle contraction is **to bind with troponin, changing its shape so that the actin filament is exposed.**

Exercise | Q 1. (G) | Page 213

Choose the correct option.

Hyper-secretion of parathormone can cause which of the following disorders?

1. Gout
2. Rheumatoid arthritis
3. **Osteoporosis**
4. Gull's disease

SOLUTION

Osteoporosis

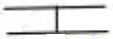
Exercise | Q 1. (H) | Page 213

Choose the correct option.

Select correct option between two nasal bones

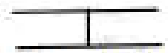
1. 
Scarf joint

2. 
Lap joint

3. 
Butt joint

4. 
Serrate joint

SOLUTION


Butt joint

Exercise | Q 2. (A) | Page 213

Answer the following question.

What kind of contraction occurs in your neck muscles while you are reading your class assignment?

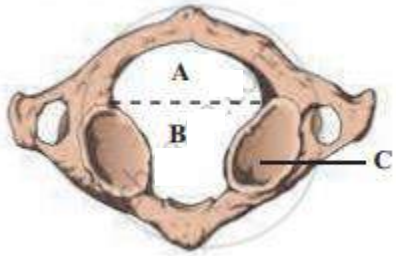
SOLUTION

1. Isometric contractions occur in the neck muscles while reading class assignments.
2. These contractions are important for supporting objects in a fixed position.

Exercise | Q 2. (B) | Page 213

Answer the following question.

Observe the diagram and enlist importance of A, B and C.



SOLUTION

1. A – Posterior portion of the vertebral foramen of atlas vertebrae; Importance - The spinal cord runs through this portion of the vertebral foramen
2. B – Anterior portion of the vertebral foramen of axis vertebrae; Importance – In this portion, the odontoid process of axis vertebrae forms ‘NO’ joint.

3. C – Inferior articular facet; Importance – It articulates with a superior articular facet of axis and permits rotatory movement of head.

Exercise | Q 2. (C) | Page 213

Answer the following question.
Raju intends to train biceps; while exercising using dumbbells, which joints should remain stationary and which should move?

SOLUTION

While performing an exercise of biceps using dumbbells, the joint which should remain stationary is wrist joint or radiocarpal joint, ball and socket joint of the shoulder. The only joint which should move is hinge joint of the elbow.

Exercise | Q 2. (D) | Page 213

Answer the following question.
In a road accident, Moses fractured his leg. One of the passers-by tied a wooden plank to the fractured leg while Moses was rushed to the hospital. Was this essential? Why?

SOLUTION

1. Fracture is a significant and traumatic injury which requires medical attention however, getting timely first aid is important.
2. If any bone is fractured, it is essential that the fractured part be immobilized to prevent further injury. It can be done with the help of any available wooden plank or batons or rulers. Thus, a wooden plank was tied to Moses's fractured leg as first aid for fracture.
3. A fractured bone is immobilized to prevent the sharp edges of the fractured bone from moving and cutting tissue, muscle, blood vessels and nerves. Immobilization can also help reduce pain or control shock.

Exercise | Q 2. (E) | Page 213

Answer the following question.
Sprain is more painful than fracture. Why?

SOLUTION

1. A sprain is an injury that involves the ligaments (tissues that connect bones at joints), whereas a fracture is an injury that involves bones.
2. Sprains can be of three degree: 1st degree: Mild with micro-tears, 2nd degree: Partial with a visible tear in a ligament, 3rd degree: Completely torn ligament.
3. If a sprain is 3rd degree, it will be more painful than a fracture. It usually requires surgery to fix this injury, while breaking a bone, most of the time does not require surgery.

4. Breaks or Fractures also vary greatly. Minor fractures (like stress/ hairline fractures) are much less painful than compound/ complex fractures in which the bone may be cracked into half.
5. Blood supply is essential for growth and regeneration. Bones are highly vascularized whereas, ligaments are not. This causes the bones to heal comparatively faster than severe sprains. Thus, the duration of enduring pain until the injury heals also differs.
6. Also, ligaments have a rich supply of sensory nerves, which may also be responsible for an elevated sense of pain during severe sprains

Exercise | Q 2. (F) | Page 213

Answer the following question.
Why a red muscle can work for a prolonged period whereas white muscle fibre suffers from fatigue after a shorter work?

SOLUTION

1. Red muscle fibres contain a large amount of myoglobin and mitochondria (site of aerobic respiration), whereas white muscles fibres contain a lesser amount of myoglobin and mitochondria.
2. Myoglobin is an iron-containing pigment that carries oxygen molecules to muscle tissues. The abundance of these pigments in red muscle fibres supports a higher rate of aerobic respiration, whereas white muscle fibres have fewer mitochondria and depend upon anaerobic respiration.
3. Anaerobic respiration in muscle white fibres leads to the production of lactic acid and accumulation of higher levels lactic acid can result in fatigue in white muscle fibres. Thus, red muscle fibres can perform prolonged work and show less fatigue due to accumulation of negligible amount loss or of lactic acid, whereas white muscle fibres suffer from fatigue after a shorter work due to accumulation of the higher amount of lactic acid.

Exercise | Q 3. (A) | Page 214

Answer the following question.
How is the structure of sarcomere suitable for the contractility of the muscle? Explain its function according to sliding filament theory.

SOLUTION

1. A sarcomere is the functional unit of myofibril. It has a specific arrangement of actin and myosin filaments. The components of sarcomere are organized into a variety of bands and zones. Actin and myosin are referred as contractile proteins.

Actin is called as thin filament whereas myosin in called thick filament.
The structure of sarcomere:

2. **'A'** band – dark bands present at the centre of sarcomere and contain myosin as well as actin.
   'H' zone or Hensen's zone – light area present at the centre of 'A' band
   'M' line – present at the centre of 'H' zone
   'I' band – light bands present on the either side of 'A' band containing only actin
   'Z' line – adjacent 'I' bands are separated by 'Z' line.

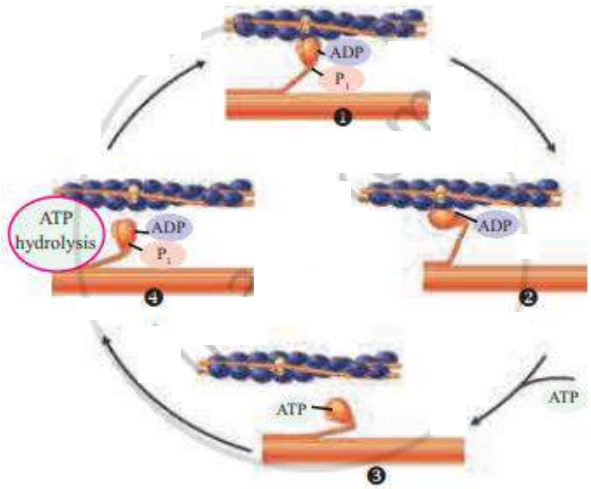
3. **Sliding filament theory:**
   It was put forth by H.E Huxley and A.F Huxley. It is also known as 'Walk along with theory' or Ratchet theory.

- According to the sliding filament theory, the interaction between actin and myosin filaments is the basic cause of muscle contraction. The actin filaments are interdigitated with myosin filaments.

- The head of the myosin is joined to the actin backbone by a cross-bridge forming a hinge joint. From this joint, myosin head cannot tilt forward or backward. This movement is an active process as it utilizes ATP.

- Myosin head contains ATPase activity. It can derive energy by the breakdown of ATP molecule. This energy can be used for the movement of myosin head.

- During contraction, the myosin head gets attached to the active site of actin filaments and pull them inwardly so that the actin filaments slide over the myosin filaments. This results in the contraction of muscle fibre.



Cyclic events in muscle contraction

Exercise | Q 3. (B) | Page 214

Answer the following question in detail.
Ragini, a 50-year-old office goer, suffered hair-line cracks in her right and left foot in short intervals of time. She was worried about minor jerks leading to hairline cracks in bones. Doctor explained to her why it must be happening and prescribed medicines.

- What must be the cause of Ragini's problem?
- Why has it occurred?
- What precautions she should have taken earlier?
- What care she should take in the future?

SOLUTION

1. Considering Ragini's age, she may be undergoing menopause. After menopause, oestrogen level declines resulting in lower bone density.
2. a. In this disorder, bones become porous and hence brittle. It is primarily an age-related disease and is more common in women than men.

   b. Osteoporosis may be caused due to decreasing estrogen secretion after menopause, deficiency of vitamin D, low calcium diet, decreased secretion of sex hormones and thyrocalcitonin.
3. As age advances, bone resorption outpaces bone formation. Hence, the bones lose mass and become brittle. More calcium is lost in the urine, sweat, etc. than it is gained through diet. Thus, the prevention of disease is better than treatment by consuming an adequate amount of calcium and exercise at a young age.
4. A person with previous hairline fractures is more susceptible to the reoccurrence of fractures. Hence, Ragini needs to take her medications and supplements properly, avoid jerky movements, and maintain body weight.

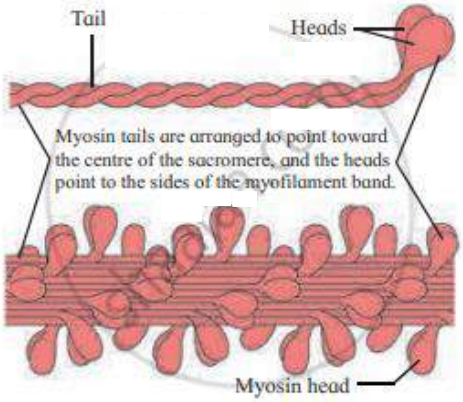
Exercise | Q 3. (C) | Page 214

Answer the following question.

How does the structure of actin and myosin help in muscle contraction?

SOLUTION

- **Myosin filament:**



1. Each myosin filament is a polymerized protein. Many meromyosins (monomeric proteins) constitute one thick filament.

2. Myosin molecule consists of two heavy chains (heavy meromyosin / HMM) coiled around each other forming a double helix. One end of each of these chains is projected outwardly is known as a cross bridge. This end folds to form a globular protein mass called myosin head.

3. Two light chains are associated with each head forming 4 light chains/light meromyosin / LMM.

4. Myosin head has a special ATPase activity. It can split ATP to produce energy.

5. Myosin contributes 55% of muscle proteins.

6. In sarcomere, myosin tails are arranged to point towards the centre of the sarcomere and the heads point to the sides of the myofilament band.

- **Actin filament:**
  It is a complex type of contractile protein. It is made up of three components:

1. **F actin:** It forms the backbone of actin filament. F actin is made up of two helical strands. Each strand is composed of polymerized G actin molecules. One ADP molecule is attached to G actin molecule.

2. **Tropomyosin:** The actin filament contains two additional protein strands that are polymers of tropomyosin molecules. Each strand is loosely attached to an F actin. In the resting stage, tropomyosin physically covers the active myosin-binding site of the actin strand.

3. **Troponin:** It is a complex of three globular proteins, is attached approx. 2/3rd distance along each tropomyosin molecule. It has affinity for actin, tropomyosin and calcium ions. The troponin complex is believed to attach the tropomyosin to the actin. The strong affinity of troponin for calcium ions is believed to initiate the contraction process.

Exercise | Q 3. (D) | Page 214

Answer the following question in detail.
Justify the structure of atlas and axis vertebrae with respect to their position and function.

SOLUTION

- **Atlas vertebrae:**

1. Atlas is the ring-like, 1st cervical vertebrae. It has anterior, posterior arches and large lateral masses.
2. It lacks centrum and spinous process. The superior surfaces of the lateral masses are concave and are known as superior articular facets.
3. These facets articulate with the occipital condyles of the occipital bone thereby forming atlanto-occipital joints. This articulation permits 'YES movement' or nodding movement.
4. The inferior surfaces of the lateral masses known as inferior articular facets articulate with axis vertebrae.

- **Axis vertebrae:**

1. It is the 2nd cervical vertebrae.
2. A peg-like process called odontoid process projects superiorly through the anterior portion of the vertebral foramen of the atlas.
3. The odontoid process forms a pivot on which the atlas and head rotate. This arrangement allows 'NO movement' or side to side movement of the head.
4. The articulation formed between the anterior arch of the atlas, the odontoid process of the axis, and between their articular facets is called the atlanto-axial joint.

Exercise | Q 3. (E) | Page 214

Observe the blood report given below and diagnose the possible disorder.

Report D

PERFECT PATHOLOGY Reg. No:- _____
Dr. _____ Date:- _____
Patient name:- _____ Age:- _____ M/F
Reference:-

Examination of Blood

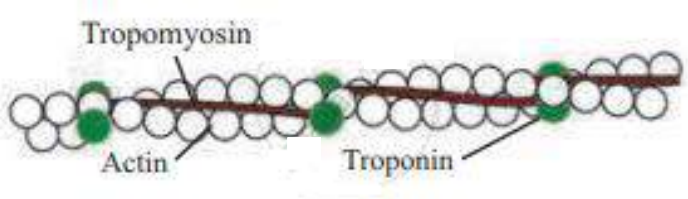
Test	Result	Normal value
Uric Acid	9.2	2.5 - 7.0 mg/dL
Blood Urea Nitrogen (BUN)	24	10 - 20 mg/dL

SOLUTION

On observing Report D, it is clear that the level of uric acid is more than normal, thus the patient must be suffering from gouty arthritis.
Also, the elevated blood urea nitrogen (BUN) indicates dysfunctional liver and/ or kidneys. It generally occurs due to a decrease in GFR, caused by renal disease or obstruction of the urinary tract.

Exercise | Q 4. (A) | Page 214
Write a short note on Actin filament.

SOLUTION



The actin filament is a complex type of contractile protein. It is made up of three components:

1. **F actin:** It forms the backbone of the actin filament. F actin is made up of two helical strands. Each strand is composed of polymerized G actin molecules. One ADP molecule is attached to G actin molecule.

2. **Tropomyosin:** The actin filament contains two additional protein strands that are polymers of tropomyosin molecules. Each strand is loosely attached to an F actin. In the resting stage, tropomyosin physically covers the active myosin-binding site of the actin strand.

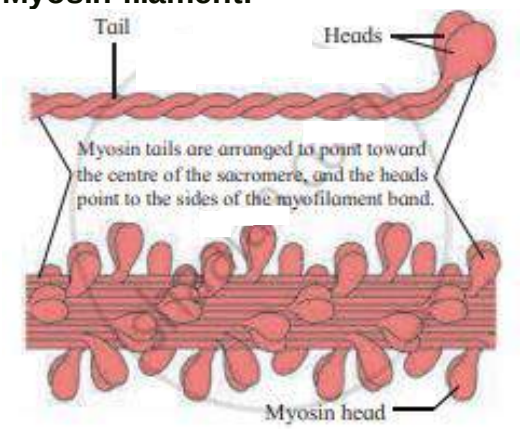
3. **Troponin:** It is a complex of three globular proteins, is attached approx. 2/3rd distance along each tropomyosin molecule. It has an affinity for actin, tropomyosin, and calcium ions. The troponin complex is believed to attach the tropomyosin to the actin. The strong affinity of troponin for calcium ions is believed to initiate the contraction process.

Exercise | Q 4. (B) | Page 214

Write short notes on Myosin filament.

SOLUTION

Myosin filament:



1. Each myosin filament is a polymerized protein. Many meromyosins (monomeric proteins) constitute one thick filament.
2. Myosin molecule consists of two heavy chains (heavy meromyosin / HMM) coiled around each other forming a double helix. One end of each of these chains is projected outwardly is known as a cross bridge. This end folds to form a globular protein mass called myosin head.
3. Two light chains are associated with each head forming 4 light chains/light meromyosin/LMM.
4. Myosin head has a special ATPase activity. It can split ATP to produce energy.
5. Myosin contributes 55% of muscle proteins.
6. In sarcomere, myosin tails are arranged to point towards the centre of the sarcomere and the heads point to the sides of the myofilament band.

Exercise | Q 4. (C) | Page 214

Write a short note on role of calcium ions in contraction and relaxation of muscles.

SOLUTION

Calcium ions play a major role in the contraction and relaxation of muscles.

1. Calcium ions are released from the sarcoplasm during muscle contraction and stored in the sarcoplasmic reticulum during muscle relaxation.

2. When a skeletal muscle is excited and an action potential travels along the T tubule, the concentration of calcium ions increases.

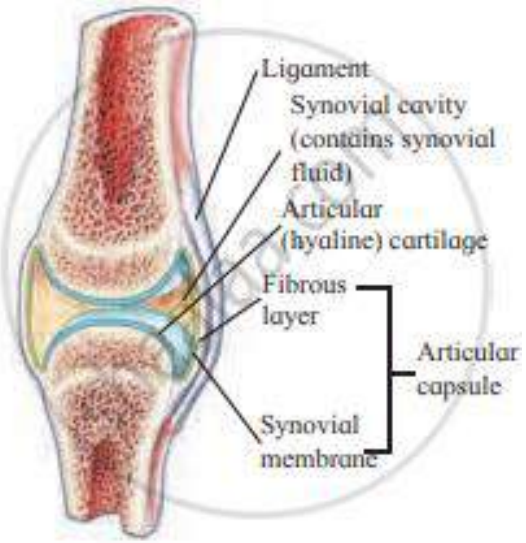
3. These calcium ions bind to troponin which in turn undergoes a conformational change that causes tropomyosin to move away from the myosin-binding sites on actin. Once these binding sites are free, myosin heads bind to them to form cross-bridges, and the muscle fiber contracts.

4. The decrease in calcium ion concentration in the sarcoplasmic reticulum causes tropomyosin to slide back and block the myosin-binding sites on actin. This causes the muscle to relax.

Exercise | Q 5. (A) | Page 214

Draw labelled diagram Synovial joint.

SOLUTION

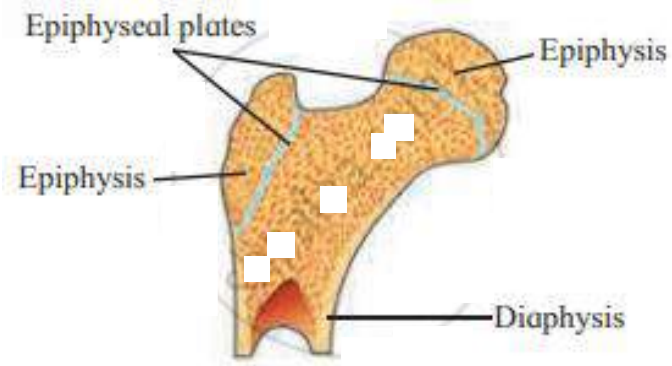


Exercise | Q 5. (B) | Page 214

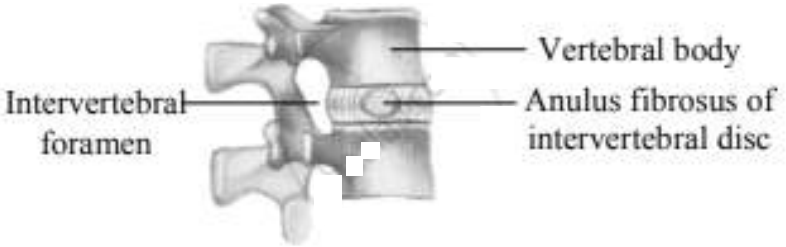
Draw labelled diagram of different cartilaginous joints.

SOLUTION

Synchondroses:



Symphysis:



Pelvic girdle: