16. Skeleton and Movements

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1. Choose the correct option

A. The functional unit of striated muscle is .....

a. cross bridges

b. myofibril

c. sarcomere

d. z-band

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

a. Carpals

b. Tarsal

c. Metacarpals

d. Metatarsals

C. Muscle fatigue is due to accumulation of .....

a. pyruvic acid

b. lactic acid

c. malic acid

d. succinic acid

D. Which one of the following is NOT antagonistic muscle pair?

a. Flexo-extensor

b. Adductor-abductor

c. Levator-depressor

d. Sphinetro-suprinater

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

a. due to osmosis

b. due to plasmolysis

c. due to electrolysis

d. due to photolysis

F. Role of calcium in muscle contraction is .....

a. to break the cross bridges as a cofactor in the hydrolysis of ATP

b. to bind with troponin, changing its shape so that the actin filament is exposed

c. to transmit the action potential across the neuromuscular junction.

d. to re-establish the polarisation of the plasma membrane following an action potential

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

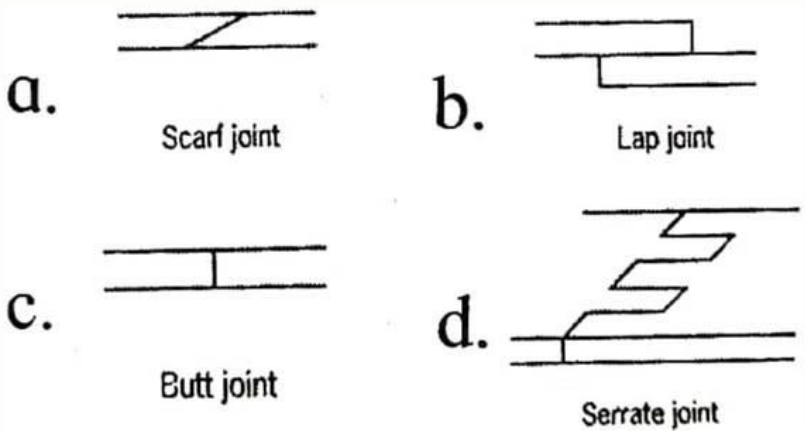
a. Gout

b. Rheumatoid arthritis

c. Osteoporosis

d. Gull's disease

H. Select correct option between two nasal bones



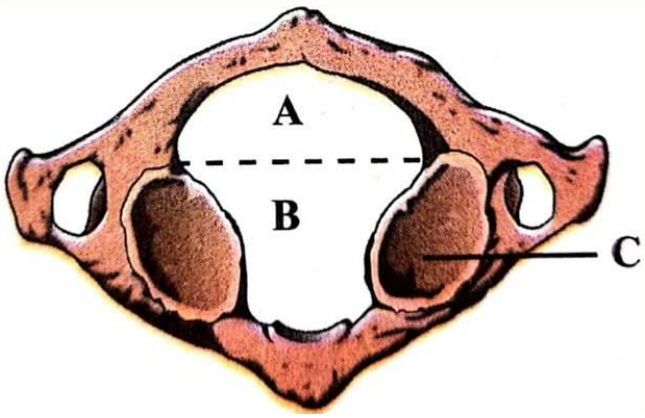
Ans. (c) Butt joint

2. Answer the following questions

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

Ans. There are voluntary muscle contractions in the neck muscles while reading. Also eyes show movements while reading.

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



Ans. A: Posterior portion of vertebral foramen of atlas vertebra through which spinal cord runs. Medulla oblongata continues as spinal cord after it exits from foramen magnum of skull.

B: Anterior portion of vertebral foramen of atlas vertebra. In this portion fits the odontoid process of axis vertebra forming a pivot or 'no' joint.

C: C are facets for articulation with occipital condyles. On these the skull rests.

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

Ans. Biceps is a flexor muscle while its antagonistic muscle is triceps which is an extensor.
Keeping upper arms stationary and curling the weights up to shoulder level by moving hinge joints at elbow while contracting the biceps, is the method to build the biceps.

D. In a road accident, Moses fractured his leg. One of the passers by, tied a wodden plank to the fractured leg while Moses was rushed to the hospital Was this essential? Why?

Ans. Fractured leg has to be tied to wooden plank for support. The plank acts as a splint and stabilizes the fractured part. The injured area has to be immediately immobilized so that further trauma will not occur to the victim. Restricting the movement of a broken bone in leg of Mr. Moses was most critical for proper healing. To do this, the passerby must have used a wooden plank acting as a splint. So this was most essential action. Rushing him to hospital further must have helped in getting appropriate medical treatment.

E. Sprain is more painful than fracture. Why?

Ans. It cannot be said that sprain is more painful than fracture. Fracture is definitely more traumatic than the sprain making a person immobile. However, the sprain is the injury to the ligament or tendon. Such injuries take more time to heal. Bones heal faster as they have better blood supply.

F. Why a red muscle can work for a prolonged period whereas white muscle fibre suffers from fatigue after a shorter work? (Refer to chapter animal tissues.)

Ans. Red muscles possess large amount of myoglobin. In them, there are dark bands or fibers which contain many mitochondria. Mitochondria being site of cellular respiration can yield more energy. White muscles are the muscles in which white fibres are dominant, and they have a small amount of myoglobin and mitochondria in them. Thus after prolonged working, their ATP is exhausted. There is anaerobic oxidation leading to accumulation of lactic acid. This causes fatigue in the muscles.

3. Answer the following questions in detail

A. How is the structure of sarcomere suitable for the contractility of the muscle? Explain its function according to sliding filament theory. (Refer to chapter animal tissues.)

Ans. (1) Muscle fibres are composed of myofibrils which are arranged in a parallel arrangement.

(2) The sarcomeres are arranged end to end, running the length of each myofibril.

(3) A given myofibril contains approximately 10,000 sarcomeres. Each sarcomere is small and consists of thick and thin bundles of proteins referred to as myofilaments.

(4) Thick filaments contain myosin, while thin filaments contain actin.

(5) Actin and myosin collectively are referred to as the contractile proteins, which cause muscle shortening when they interact with each other.

(6) Additionally, thin filaments contain the regulatory proteins troponin and tropomyosin, which regulate interaction between the contractile proteins.

(7) These contractile proteins cause muscles to shorten when they interact.

(8) The I band is that part of the sarcomere that contains thin filaments, while the A band contains an area of overlap between the thin and the thick filaments.

(9) Single I band spans two neighbouring sarcomeres. Z line attaches those neighbouring sarcomeres.

(10) The thin filaments are attached to the Z lines on each end of the sarcomere, while the thick filaments reside in the middle of the sarcoma.
(11) This particular arrangement in the myofibril makes the filaments to slide against each other as explained in sliding filament theory.

details of sliding filament theory:

(1) Sliding filament theory was put forth by H.E. Huxley and A.F. Huxley.

(2) It is also called walk along theory or Ratchet theory.

(3) Interaction between actin and myosin is the basic cause of muscular contraction. Actin filaments are inter-digitated with myosin filaments.

(4) The head of the myosin is joined to the actin backbone by a cross bridge forming a hinge joint.

(5) From this joint, head cannot tilt in forward and backward directions.

(6) This movement is an active process which requires use of ATP.

(7) Myosin head contains ATPase activity.

(8) It can derive energy by the breakdown of ATP molecule.

(9) This energy can be used for the movement of myosin heads.

(10) During contraction process, the myosin heads gets attached to the active site of actin filaments and pull them inwardly, so that actin filaments slide over the myosin filaments. This results in the contraction of muscle fibre.

B. 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 hair

line 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 future?

Ans. Ragini may be suffering from osteoporosis as can be seen by the history of frequent fractures in her body. From her age, it can be concluded that she may be undergoing menopause resulting into lesser amount of estrogen. This results into loss of bone mass. Her diet may also be deficient in calcium and phosphorus. Even vitamin D deficiency may be causing the above symptoms.

C. How does structure of actin and myosin help muscle contraction?

Ans. Actin filament: Actin is a contractile protein which is a complex of three different components:

(1) F actin: F actin is double stranded protein which forms the backbone of actin filament. Each strand has polymerized G actin molecules. One ADP molecule is attached to each G actin molecule.

(2) Tropomyosin: In each actin filament there are two additional protein strands which are polymers of tropomyosin molecules. Each of this strand is loosely attached to F actin. When the muscle fibre is in the resting stage, this tropomyosin physically covers the active binding sites. On these sites, there is myosin of the actin strand.

(3) Troponin: Three globular proteins form this complex. They are attached approximately 2/3rd distance along each tropomyosin molecule. Troponin has affinity for actin, tropomyosin and calcium ions. The troponin complex attaches the tropomyosin to the actin. Initiation of contraction of muscles starts due to calcium ions which have strong affinity with troponin.

Myosin filament:

(1) Each myosin filament is a polymerized protein.

(2) Many meromyosins which are monomeric proteins constitute one thick filament of myosin.

(3) Myosin molecule has two heavy chains. These are called heavy meromyosin or HMM. They are coiled around each other forming double helix.

(4) One end of each of these chains is projected outwardly. This is called a cross bridge. This end is folded into a globular protein mass called myosin head.

(5) Two light chains of light meromyosin or LMM are associated with each head. Thus total 4 light chains are seen.

(6) In myosin head special ATPase activity is seen.

(7) It can split ATP to produce energy.

(8) 55% of muscle proteins are made up of myosin.

(9) In the sarcomere, myosin tails are arranged to point toward the centre of the sacromere, and the heads point to the sides of the myofilament band.

D. Justify the structure of atlas and axis vertebrae with respect to their position and function.

Ans. 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.

E. 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/l
Blood Urea Nitrogen (Bun)	24	10 - 20 mg/dl

Ans. From the blood report D, it is clear that the patient has more uric acid than the normal range. This may indicate the gout. If the person's clinical examination is revealing arthritis, then the patient must be suffering from gouty arthritis. There is slight increase in BUN too. This indicates that the person may have kidney problem. BUN is Blood urea nitrogen. The presence of BUN indicates that either the person's kidney or liver is not working properly or may be his diet is of high protein content.

The diagnosis thus can be gout with some problem in kidney. But it has to be substantiated with clinical and other examinations.

4. Write short notes on following points

A. Actin filament

Ans. Actin is a contractile protein which is a complex of three different components:

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C. Role of calcium ions in contraction and relaxation of muscles.

Ans. (1) The sarcoplasmic reticulum stores calcium ions, which are released when a muscle cell is stimulated. The calcium ions then enable the cross-bridge muscle contraction cycle.

(2) The muscle contraction cycle is triggered by calcium ions binding to the protein complex troponin. This exposes the active-binding sites on the actin.

(3) As soon as the actin-binding sites are uncovered, the high-energy myosin head bridges the gap, forming a cross-bridge.

(4) The concentration of calcium within muscle cells is controlled by the sarcoplasmic reticulum. Muscle contraction ends when calcium ions are pumped back into the sarcoplasmic reticulum, allowing the muscle cell to relax.

(5) During stimulation of the muscle cell, the motor neuron releases the neurotransmitter acetylcholine, which then binds to a post-synaptic nicotinic acetylcholine receptor.

(6) A change in the receptor conformation causes an action potential. This action

potential activates calcium channels, which are present in the plasma membrane.

(7) The inward flow of calcium from calcium channels activates receptors to release calcium ions from the sarcoplasmic reticulum.

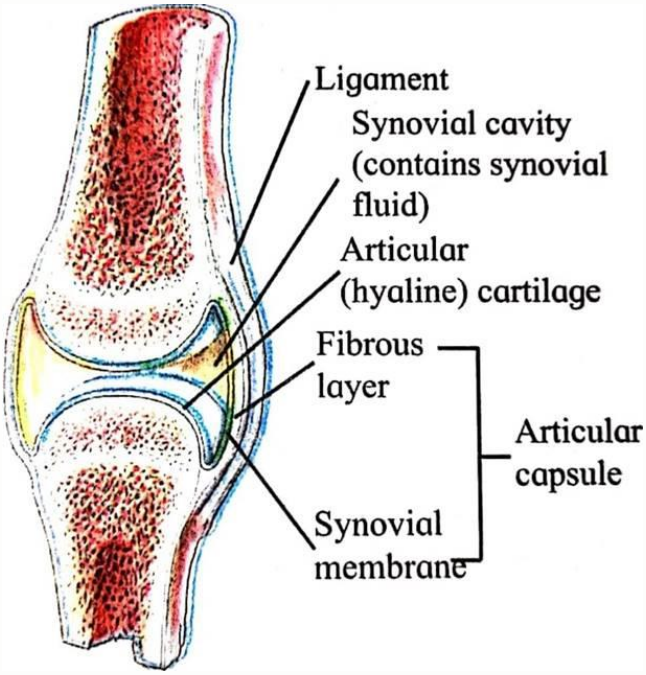
(8) This mechanism is called calcium-induced calcium release (CICR).

(9) The outflow of calcium allows the myosin heads to access the actin cross-bridge binding sites, permitting muscle contraction.

5. Draw labelled diagrams

A. Synovial joint.

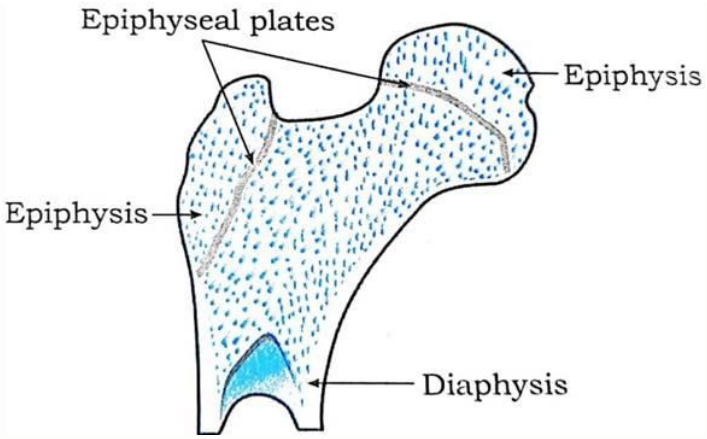
Ans.



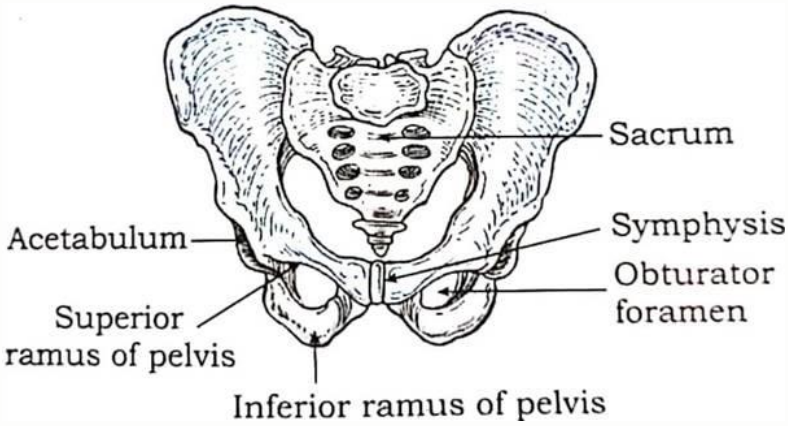
B. Different cartilagenous joints.

Ans.

(a) Synchondroses



(b) Symphysis



(c) Intervertebral joints