

# KATTAR NEET (2026)

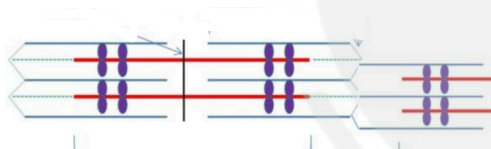
## Zoology By Samapti Sinha Ma'am

### Locomotion and Movement

**Q1** A scientist observes a muscle fiber under experimental conditions where the sarcoplasmic reticulum is completely depleted of calcium ions. If ATP is still available in abundance, what would be the immediate consequence upon stimulation of this muscle fiber by a motor neuron?

- (A) Formation of cross-bridges would occur, leading to muscle contraction.
- (B) Troponin would bind to actin, initiating the sliding of filaments.
- (C) The myosin head would hydrolyze ATP but fail to bind to actin.
- (D) The muscle fiber would immediately enter a state of rigor mortis.

**Q2** Observe the given diagram of a sarcomere in its relaxed state.



If this sarcomere undergoes maximal contraction, which of the following statements accurately describes the changes in its bands and zones?

- (A) Both the A band and I band shorten, while the H zone disappears.
- (B) The A band remains the same length, the I band shortens, and the H zone may disappear.
- (C) The A band shortens, the I band remains the same length, and the H zone widens.
- (D) All bands and zones shorten proportionally.

**Q3** Which of the following statements **accurately** differentiate between Skeletal, Visceral, and Cardiac muscles?

- I. Skeletal muscles are voluntary and striated, primarily involved in locomotory actions and

changes of body postures.

II. Visceral muscles are non-striated and involuntary, assisting in the transportation of substances like food through the digestive tract.

III. Cardiac muscles are striated and involuntary, and their activities are directly controlled by the nervous system only.

IV. All three types of muscles are specialized tissues of mesodermal origin and possess properties like excitability and contractility.

- (A) I and II only
- (B) I, II and III only
- (C) I, II and IV only
- (D) I, II, III and IV

**Q4** A forensic anthropologist is examining a partial human skeleton and needs to determine which bones belong to the axial skeleton and which to the appendicular skeleton. They find the following bones:

- P. Ribs
- Q. Femur
- R. Sternum
- S. Carpals
- T. Vertebral column

Which of the following combinations **correctly** identifies bones belonging to the *axial skeleton*?

- (A) P, Q, R only
- (B) Q, S only
- (C) P, R, T only
- (D) P, Q, R, S, T

**Q5** Consider the following statements regarding movement and locomotion:

- I. Cells of human body exhibit only two types of movement ciliary and muscular.
- II. Streaming of protoplasm in *Amoeba* is a simple form of movement, but not considered locomotion.



III. Organisms like *Paramecium* use cilia for both food movement through the cytopharynx and for locomotion.

IV. Locomotion is generally undertaken by animals for purposes such as searching for food, shelter, or suitable breeding grounds.

Which of the above statements are **incorrect**?

- (A) I only
- (B) II and III only
- (C) I and IV only
- (D) I, II and IV only

**Q6** A marathon runner experiences severe muscle fatigue and cramping towards the end of a race. This is primarily attributed to a shift in their muscle metabolism. Consider the following statements in this context:

I. Muscle fatigue can result from the accumulation of lactic acid due to anaerobic breakdown of glycogen.

II. Red fibres are well-suited for prolonged aerobic activities as they contain high myoglobin and plenty of mitochondria.

III. White fibres depend primarily on anaerobic processes for energy and have less myoglobin and fewer mitochondria.

IV. The accumulation of lactic acid in muscles is always irreversible and leads to permanent damage.

Which of the above statements **correctly** explain the physiological basis of muscle fatigue and muscle fiber types?

- (A) I, II and III only
- (B) I and IV only
- (C) II and III only
- (D) I, II, III and IV

**Q7** Match the **List-I** with **List-II**.

List-I (Muscle protein)		List-II (Primary Function/Characteristic)	
(A)	Actin	(I)	Binds to ATP and has ATPase activity

(B)	Myosin	(II)	Forms the thin filament backbone
(C)	Troponin	(III)	Covers myosin binding sites on action
(D)	Tropomyosin	(IV)	Contains $\text{Ca}^{2+}$ binding sites

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

- (A) A-II, B-IV C-I, D-III
- (B) A-II, B-I, C-IV, D-III
- (C) A-III, B-I, C-II, D-IV
- (D) A-III, B-II, C-IV, D-I

**Q8** A researcher is studying two different types of muscle fibers from an unknown organism. Fiber X appears reddish and functions for prolonged, sustained movements, while Fiber Y is pale and primarily involved in rapid, powerful bursts of activity. Based on this observation, what distinct difference would the researcher expect in the internal cellular machinery of Fiber Y compared to Fiber X, specifically regarding calcium storage?

- (A) Fiber Y would have a significantly larger number of mitochondria.
- (B) Fiber Y would possess a less developed sarcoplasmic reticulum.
- (C) Fiber Y would have a higher amount of sarcoplasmic reticulum.
- (D) Fiber Y would contain more myoglobin.

**Q9** Given below are two statements:

**Statement I:** Ciliary movement occurs in most of our internal tubular organs which are lined by squamous 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.

**Statement II:** Three types of joints are formed between bones or between bone and cartilage – fibrous, cartilaginous and synovial. Synovial joints allow considerable movements and therefore, play a significant role in locomotion.



In the light of given statements, choose the most appropriate answer from the options given below.

- (A) Statement I is correct, and Statement II is incorrect.
- (B) Statement I is incorrect, and Statement II is correct.
- (C) Both Statement I and Statement II are correct.
- (D) Both Statement I and Statement II are incorrect.

**Q10** Identify the **incorrect** option.

- (A) Muscles with characteristic striations and involuntary nature are muscles of the eyelids.
- (B) Skeletal system consists of a framework of bones and a few cartilages.
- (C) The junction between a motor neuron and the sarcolemma of the muscle fibre is called the motor-end plate.
- (D) Methods of locomotion performed by animals vary with their habitats and the demand of the situation.

**Q11** A novel toxin is discovered that specifically blocks the release of neurotransmitters at the neuromuscular junction without affecting the neuron's ability to generate action potentials. What would be the direct physiological consequence of this toxin on skeletal muscle function?

- (A) Sarcolemma would generate an action potential, but calcium ions would not be released.
- (B) Acetylcholine would be released, but the sarcolemma would not depolarize.
- (C) Muscle contraction would occur but would be prolonged due to lack of relaxation signals.
- (D) No action potential would be generated in the sarcolemma, and thus no muscle contraction.

**Q12** Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

**Assertion A:** Myasthenia gravis is an autoimmune disorder affecting neuromuscular junction leading to fatigue, weakening and paralysis of skeletal muscle.

**Reason R:** It is caused by genetic mutation affecting the production of acetylcholine.

In the light of the above statements, choose the **correct** answer from the options given below:

- (A) A is true but R is false.
- (B) A is false but R is true.
- (C) Both A and R are true and R is the correct explanation of A.
- (D) Both A and R are true but R is NOT the correct explanation of A.

**Q13** A physiotherapist is explaining different types of joints to a patient. They mention:

- I. Fibrous joints, found between flat skull bones, allow no movement and fuse with dense fibrous connective tissues.
- II. Cartilaginous joints, like those between adjacent vertebrae, permit considerable movement due to the presence of cartilage.
- III. Synovial joints, characterized by a fluid-filled cavity, are crucial for locomotion and allow considerable movement.

IV. The knee joint is an example of a ball and socket joint, allowing multi-axial movement.

Which of the above statements is/are **correct**?

- (A) I and III only
- (B) II and IV only
- (C) I, III and IV only
- (D) I, II, III and IV

**Q14** Analyze the following statements regarding bones and cartilages:

- I. Both bone and cartilage are specialized connective tissues.
- II. Bone has a hard matrix due to calcium salts, while cartilage has a pliable matrix due to chondroitin salts.
- III. The number of bones in the human skeletal system is fixed at 206, and this number remains constant throughout life.



IV. The hyoid bone is a single U-shaped bone present at the base of the buccal cavity and is part of the facial skeleton.

Which of the above statements is/are **correct**?

- (A) I and II only
- (B) I, II and III only
- (C) I, II and IV only
- (D) I, II, III and IV

**Q15** Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

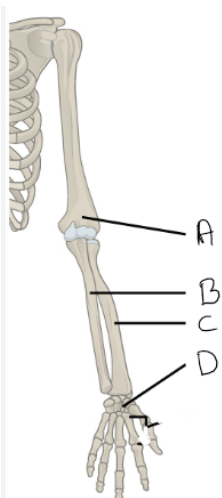
**Assertion A:** Rigor mortis, the stiffening of muscles after death, occurs due to the continuous formation of new cross-bridges between actin and myosin.

**Reason R:** After death, ATP production ceases, preventing the detachment of myosin heads from actin filaments.

In the light of the above statements, choose the **correct** answer from the options given below:

- (A) A is true but R is false.
- (B) A is false but R is true.
- (C) Both A and R are true and R is the correct explanation of A.
- (D) Both A and R are true but R is NOT the correct explanation of A.

**Q16** Identify the bones labeled A, B, C, and D in the given diagram of a human appendicular skeleton.



Which of the following **correctly** identifies all the labeled parts?

- (A) A: Humerus, B: Ulna, C: Radius, D: Carpals

(B) A: Radius, B: Phalanges, C: Tibia, D: Metatarsals

(C) A: Humerus, B: Radius, C: ulna, D: carpals

(D) A: Scapula, B: Clavicle, C: Pelvis, D: Patella

**Q17** Regarding the vertebral column and thoracic cage:

I. The total number of vertebrae in the adult human spine is typically 26.

II. Ribs articulate anteriorly with the sternum and posteriorly with the thoracic vertebrae.

III. The lumbar vertebrae are generally larger and more robust than cervical vertebrae due to their weight-bearing function.

IV. The first seven pairs of ribs are called true ribs because they directly articulate with the sternum via hyaline cartilage.

How many of the above statements are **incorrect**?

- (A) four
- (B) five
- (C) Two
- (D) zero

**Q18** Consider the following statements regarding the human skull:

I. The frontal bone forms the anterior part of the cranium and part of the orbit.

II. The maxilla contributes to the upper jaw and the floor of the orbit.

III. The zygomatic bone forms the cheekbone and contributes to the lateral wall of the orbit.

IV. The temporal bone contains the external acoustic meatus and articulates with the parietal bone.

Which of the above statements are **correct**?

- (A) I, II, and III only
- (B) I, III, and IV only
- (C) II, III, and IV only
- (D) I, II, III, and IV

**Q19** A patient experiences severe pain and swelling in their ankle joint, which is diagnosed as a sprain. Which type of joint is most commonly affected by sprains due to its extensive range of motion?

- (A) Fibrous joint
- (B) Cartilaginous joint



- (C) Synovial joint  
(D) Immovable joint

**Q20** Match the **List-I** with **List-II**.

	List-I		List-II
(A)	Tetany	(I)	weakening and paralysis of skeletal muscle
(B)	Myasthenia gravis	(II)	Decreased levels of estrogen
(C)	Muscular dystrophy	(III)	Wild contractions in muscles
(D)	Osteoporosis	(IV)	Progressive degeneration of skeletal muscle due to genetic disorder

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

- (A) A-II, B-I, C-IV, D-III  
(B) A-IV, B-III, C-I, D-II  
(C) A-III, B-I, C-II, D-IV  
(D) A-III, B-I, C-IV, D-II

**Q21** Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

**Assertion A:** Relaxation of a muscle fiber requires the active transport of calcium ions back into the sarcoplasmic reticulum.

**Reason R:** The binding of calcium ions to troponin prevents the binding of myosin heads to actin, thereby causing muscle relaxation.

In the light of the above statements, choose the **correct** answer from the options given below:

- (A) A is true but R is false.  
(B) A is false but R is true.  
(C) Both A and R are true and R is the correct explanation of A.  
(D)

Both A and R are true but R is NOT the correct explanation of A.

**Q22** Match the **List-I** with **List-II**.

	List-I		List-II
(A)	Patella	(I)	Part of the pectoral girdle
(B)	Scapula	(II)	Sesamoid bone in the knee
(C)	Atlas vertebra	(III)	Forms part of pelvic girdle
(D)	Ilium	(IV)	Articulates with the occipital condyles

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

- (A) A-II, B-I, C-IV, D-III  
(B) A-IV, B-III, C-I, D-II  
(C) A-III, B-I, C-II, D-IV  
(D) A-III, B-I, C-IV, D-II

**Q23** Given below are two statements:

**Statement I:** The presence of a larger number of neuromuscular junctions on a muscle fiber indicates a higher degree of fine motor control for that muscle.

**Statement II:** Osteoporosis makes bones brittle primarily because it leads to an excessive deposition of calcium salts, making the bones too rigid.

In the light of the above statements, choose the most appropriate answer from the options given below:

- (A) Statement I is correct, and Statement II is incorrect.  
(B) Statement I is incorrect, and Statement II is correct.  
(C) Both Statement I and Statement II are correct.  
(D) Both Statement I and Statement II are incorrect.

**Q24** Identify the **incorrect** statement from the following.

- (A) If a person's body lacks the enzyme required to break down acetylcholine in the synaptic

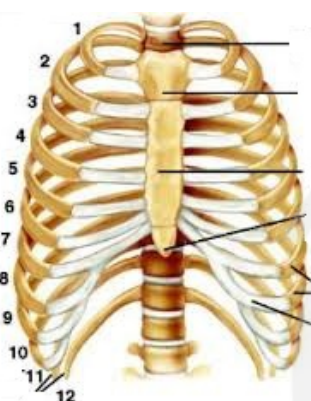




cleft, their muscles would experience prolonged contraction or spasms.

- (B) The primary reason for the red appearance of red muscle fibers is the abundance of hemoglobin.
- (C) An athlete specializing in short, powerful bursts of activity (e.g., a weightlifter) would primarily have a higher proportion of white muscle fibers in their biceps.
- (D) First seven pairs of ribs are called true ribs. Dorsally, they are attached to the thoracic vertebrae and ventrally connected to the sternum with the help of hyaline cartilage.

Q25



A forensic anthropologist is examining skeletal remains and notes that the last two pairs of ribs are not articulated directly with the sternum or indirectly via costal cartilages. What specific term is used to classify these ribs, and what major body cavity do they primarily protect?

- (A) True ribs; abdominal cavity
- (B) False ribs; thoracic cavity
- (C) Floating ribs; kidneys and upper abdominal organs
- (D) Lumbar ribs; pelvic cavity

- Q26** A long-distance runner participates in a marathon. After several hours of continuous running, they experience severe muscle pain and struggle to continue. A physiologist analyzes the runner's muscle tissue during this period. Consider the following observations made by the physiologist:

- I. There is an increased concentration of lactate in the muscle cells, indicating a shift towards anaerobic respiration.
- II. The runner's red muscle fibers are predominantly active and experiencing a depletion of their glycogen stores.
- III. There is a higher than normal concentration of creatine phosphate in the muscle, suggesting it's being rapidly re-synthesized.
- IV. The activity of  $\text{Na}^+/\text{K}^+$  pumps in the muscle cell membrane might be compromised, affecting repolarization.

Which of the following statements **correctly** explains the runner's condition?

- (A) I and II are correct, III and IV are incorrect.
- (B) I, II and IV are correct, III is incorrect.
- (C) II and III are correct, I and IV are incorrect.
- (D) I, II, III and IV are correct

- Q27** A research scientist is investigating a new drug that aims to improve muscle performance in athletes. Preliminary studies show that the drug enhances the release of calcium ions from the sarcoplasmic reticulum and prolongs their presence in the sarcoplasm.

Evaluate the potential effects of this drug on muscle contraction:

- I. It would likely lead to stronger muscle contractions by increasing the number of active cross-bridges.
  - II. The duration of muscle contraction would be shortened due to faster calcium reuptake.
  - III. The muscle would be more prone to tetanic contractions if stimulated rapidly.
  - IV. The drug primarily targets the release of acetylcholine at the neuromuscular junction.
- Which of the following statements are **correct** regarding the drug's effect?

- (A) I and III
- (B) I, II and III
- (C) I, III and IV
- (D) II, III and IV

Q28



Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

**Assertion A:** All movements in living organisms are considered locomotions.

**Reason R:** Locomotion is defined as any voluntary movement that results in a change of place or location.

In the light of the above statements, choose the **correct** answer from the options given below:

- (A) A is true but R is false.
- (B) A is false but R is true.
- (C) Both A and R are true and R is the correct explanation of A.
- (D) Both A and R are true but R is NOT the correct explanation of A.

**Q29** A patient experiences severe pain and restricted movement specifically at the joint connecting the carpal bones to the metacarpal of their thumb. Based on the unique range of motion at this joint, which type of synovial joint is most likely affected?

- (A) Hinge joint
- (B) Gliding joint
- (C) Saddle joint
- (D) Ball and socket joint

**Q30** During muscle contraction, a crucial step involves the "power stroke" where the myosin head pulls the actin filament. This process is directly dependent on:

- (A) The direct binding of ATP to the actin filament.
- (B) The availability of creatine phosphate for direct energy transfer.
- (C) The hydrolysis of ATP by the myosin head and its subsequent conformational change.
- (D) The re-uptake of calcium ions into the sarcoplasmic reticulum.

**Q31** Match **List-I** with **List-II**.

List-I	List-II
--------	---------

(A)	Fast muscle fibres	(I)	High Myoglobin content
(B)	Slow muscle fibres	(II)	Quicker formation of lactic acid
(C)	Anatomical unit	(III)	Contractile unit
(D)	Sarcomere	(IV)	Muscle fibre

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

- (A) A-I, B-II, C-IV, D-III
- (B) A-II, B-I, C-III, D-IV
- (C) A-II, B-I, C-IV, D-III
- (D) A-III, B-II, C-IV, D-I

**Q32** Which of the following statements accurately describes the skeletal articulation involved in the formation of the synovial ball-and-socket joint responsible for the widest range of motion in the upper appendicular skeleton of humans?

- (A) The proximal epiphysis of the humerus forms a ball-and-socket joint by articulating with the acetabulum of the pelvic girdle.
- (B) The head of the humerus fits into the acetabular cavity of the pectoral girdle, forming a stable synovial joint.
- (C) The humeral head articulates with the glenoid cavity of the scapula, forming a shallow, highly mobile shoulder joint.
- (D) The proximal head of the humerus articulates with the glenoid fossa of the ilium, enabling circumduction of the upper limb.

**Q33** Despite following a consistent gym-based workout routine, Sanatan notices a steady increase in his body weight over the past few weeks. Assuming his diet and hydration remain stable, which of the following provides the most scientifically accurate explanation for this weight gain?

- (A) The increase in weight is primarily due to excess lipid deposition as a result of caloric surplus.
- (B) The weight gain is attributed to hypertrophy of skeletal muscles with a concurrent reduction in fat content.



- (C) The weight gain is due to muscles looking more toned without actually increasing in muscle mass.
- (D) The body is retaining water, leading to a temporary rise in weight due to fluid accumulation body.

**Q34** Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

**Assertion A:** Cardiac muscle fibres are capable of rhythmic, involuntary contractions.

**Reason R:** Cardiac muscle fibres are multinucleate and connected by intercalated discs.

In the light of the above statements, choose the **correct** answer from the options given below:

- (A) A is true but R is false.
- (B) A is false but R is true.
- (C) Both A and R are true and R is the correct explanation of A.
- (D) Both A and R are true but R is NOT the correct explanation of A.

**Q35** During a competitive track event, an athlete stumbled mid-run and instinctively extended her arms to break the fall. As a result, the major impact was absorbed by the joints of her upper limbs. Considering the structural classification of joints and the nature of mechanical stress they endure, which combination of joint types is most likely to sustain trauma in such a scenario?

- (A) Cartilaginous and synovial joints
- (B) Fibrous and cartilaginous joints
- (C) Fibrous and synovial joints
- (D) Cartilaginous and synovial joints

**Q36** A medical researcher is examining a rare genetic disorder that affects the mineral composition of skeletal tissues. In affected individuals, the bones exhibit extreme flexibility while the cartilage shows unusual rigidity. Based on this observation and your knowledge of the skeletal system, which of the following best explains the

biochemical basis and likely functional implications of this disorder?

- (A) Deficiency of calcium salts in bones and excess deposition of chondroitin salts in cartilage, leading to compromised support and mobility
- (B) Over-mineralization of cartilage with calcium salts and excess collagen in bones, resulting in bone brittleness and flexible cartilage
- (C) Reduction in the number of bones in the axial skeleton and increase in appendicular bones, disrupting locomotion
- (D) Enhanced ossification of all cartilaginous tissues leading to a uniformly rigid skeleton and complete immobility

**Q37** Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

**Assertion A:** Myasthenia gravis causes muscle weakness that worsens with activity and improves with rest.

**Reason R:** It is an autoimmune disorder where antibodies block or destroy acetylcholine receptors at the neuromuscular junction.

In the light of the above statements, choose the **correct** answer from the options given below:

- (A) A is true but R is false.
- (B) A is false but R is true.
- (C) Both A and R are true and R is the correct explanation of A.
- (D) Both A and R are true but R is NOT the correct explanation of A.

**Q38** A 15-year-old patient is admitted with symptoms of involuntary muscle spasms and painful contraction of the muscles in the hands and feet. Blood analysis reveals significantly reduced ionized calcium levels. Considering the role of extracellular calcium in neuromuscular physiology, which of the following best explains the pathophysiological mechanism behind this presentation?

- (A)





Hypocalcemia decreases the threshold potential of neurons, increasing neuromuscular excitability and leading to tetany.

- (B) Hypocalcemia inhibits acetylcholine synthesis at the neuromuscular junction, reducing muscle contraction strength.
- (C) Hypercalcemia increases neuronal excitability, resulting in continuous muscle contraction (tetany).
- (D) Elevated calcium levels prevent repolarization of muscle fibers, causing sustained spasms.

**Q39** During muscle contraction, ATP is continuously utilized to power the sliding of actin and myosin filaments and for calcium reuptake into the sarcoplasmic reticulum. Which of the following sequences **correctly** represents the order of energy sources used by muscles from the onset of activity to prolonged contraction, along with their oxygen requirement?

- (A) Creatine phosphate → Anaerobic glycolysis → Aerobic respiration  
(Immediate → Short-term → Long-term;  
Anaerobic → Anaerobic → Aerobic)
- (B) Anaerobic glycolysis → Aerobic respiration → Creatine phosphate  
(Short-term → Long-term → Immediate;  
Anaerobic → Aerobic → Anaerobic)
- (C) Aerobic respiration → Creatine phosphate → Anaerobic glycolysis  
(Long-term → Immediate → Short-term;  
Aerobic → Anaerobic → Anaerobic)
- (D) Anaerobic glycolysis → Creatine phosphate → Aerobic respiration  
(Short-term → Immediate → Long-term;  
Anaerobic → Anaerobic → Aerobic)

**Q40** Radha runs at high intensity on a treadmill for 15 continuous minutes. After stopping abruptly, she exhibits rapid and deep breathing for several minutes. Based on your understanding of muscle metabolism and respiratory regulation, which of

the following best explains the physiological basis of her post-exercise breathing pattern?

- (A) Rapid breathing helps supply more oxygen to convert lactic acid into carbon dioxide and water.
- (B) Continuous running leads to ATP accumulation in muscle cells, which increases breathing rate.
- (C) Oxygen is required to transport more calcium ions into muscle fibers after exercise.
- (D) Rapid breathing after exercise is needed to activate myosin in relaxed muscle fibers.

**Q41** Carefully examine the following statements.

1. Each vertebra has a central hollow portion (neural canal) through which the spinal cord passes.
2. The adult human vertebral formula is  $C_7T_{12}L_7S_1C_1$ .
3. The central part of thick filament not overlapped by thin filament is called H zone which have a M line in centre to which the actin filaments are attached.
4. Ribs has two articulation surfaces on its ventral end and is hence called bicephalic.

How many of the following statements are **correct**?

- (A) One
- (B) Two
- (C) Three
- (D) Four

**Q42** Given below are two statements:

**Statement-I:** Each myosin filament is surrounded by 6 actin filaments.

**Statement-II:** Each actin filament is surrounded by 3 myosin filaments.

In the light of the above statements, choose the most appropriate answer from the options given below:

- (A) Statement-I and Statement-II both are correct.
- (B) Statement-I is correct but Statement-II is incorrect.
- (C) Statement-I is incorrect but Statement-II is correct.



(D) Statement-I and Statement-II both are incorrect.

**Q43** Identify the **correct** statement.

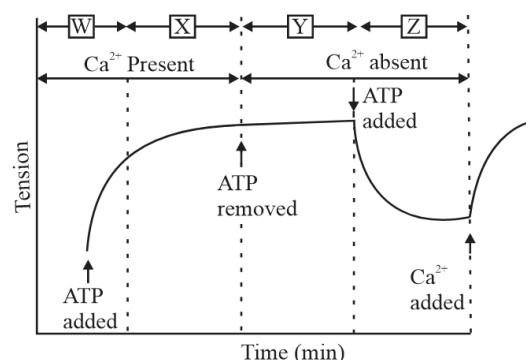
- (A) Vertebral column consists of 33 bones and 26 vertebrae.
- (B) The troponin-tropomyosin complex regenerates ATP for the myosin ATPase.
- (C) The plasma membrane and ER of striated muscles are called sarcolemma and endoplasmic reticulum respectively.
- (D) When  $\text{Ca}^{2+}$  is low, the troponin-tropomyosin complex blocks actin's binding site for myosin. When  $\text{Ca}^{2+}$  is high, the complex rolls out of the way, allowing myosin to bind to actin and initiate the cross-bridge cycle.

**Q44** In a skeletal muscle fiber, the troponin complex plays a critical regulatory role in contraction by sensing changes in intracellular  $\text{Ca}^{2+}$  levels. Which of the following statements accurately represents the molecular mechanism and structural specificity of the troponin subunits during muscle contraction?

- (A) Troponin T binds to actin, Troponin I binds calcium ions, and Troponin C displaces tropomyosin to expose myosin-binding sites on actin.
- (B) Troponin C binds calcium ions, inducing a conformational change in Troponin I, which reduces its inhibitory effect on actin, allowing tropomyosin to shift and expose myosin-binding sites.
- (C) Troponin I directly binds calcium, releasing actin, while Troponin T hydrolyzes ATP to generate conformational energy for actin-myosin binding.
- (D) Troponin C detaches from the complex upon  $\text{Ca}^{2+}$  binding, while Troponin T and I independently regulate ATPase activity of myosin.

**Q45** Rigor mortis is the rigidity that develops in dying muscles as ATP becomes depleted and cross

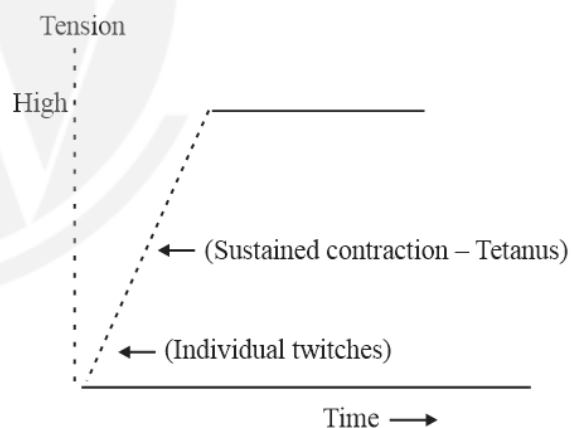
bridges remain attached. It can only be relieved by removal of  $\text{Ca}^{2+}$  and addition of ATP. Refer to given graph carefully and answer the following question.



Which of the labelled parts on the graph represents rigor mortis?

- (A) X
- (B) W
- (C) Z
- (D) Y

**Q46** The graph below (hypothetical) represents the response of a skeletal muscle to successive stimuli. Initially, individual twitches are observed, but as the frequency of stimulation increases, the muscle enters a sustained contraction phase.



Which of the following **correctly** identifies the phase of tetanisation and explains the physiological basis behind it?

- (A) Phase of tetanisation corresponds to low-frequency stimulation, where complete relaxation occurs between contractions due to recovery time.
- (B) Tetanisation occurs due to successive high-frequency stimuli, leading to summation of



contractions and sustained tension without relaxation.

- (C) Tetanisation is the result of muscle fatigue, where multiple low-energy twitches add up to a plateau of zero tension.
- (D) Tetanisation is observed only in cardiac muscle and is essential for rhythmic contraction.

**Q47** Which of the following pairs is **correctly** matched with respect to skeletal structure and function?

- (A) Atlas – First thoracic vertebra that supports the ribs
- (B) Acetabulum – Depression in femur where head of humerus fits
- (C) Glenoid cavity – Articulates with head of humerus to form shoulder joint
- (D) Tibia – Lateral bone of the lower leg, thinner than fibula

**Q48** Carefully examine the following statements about joints in the human skeletal system:

1. The joint between the atlas and occipital condyles of the skull is a condyloid joint that allows the “yes” movement of the head.
2. The joint between the atlas and axis vertebrae is a pivot joint, responsible for the “no” movement of the head.
3. The elbow joint is a synovial hinge joint permitting uniaxial movement.
4. The pubic symphysis is a synovial joint with wide range of motion.
5. Sutures of the skull are fibrous joints and are immovable.

How many of the above statements are **correct**?

- (A) Two (B) Three
- (C) Four (D) Five

**Q49** Which of the following **correctly** characterises a “fast-oxidative” type of skeletal muscle fibre?

(A) Few mitochondria and high glycogen content

(B) Less myoglobin quantity and few surrounding capillaries

(C)

Low glycolytic enzyme activity and high glycogen store

- (D) High myoglobin content and slow rate of contraction

**Q50** A 55-year-old female met with an accident that results in fracture due to her decreased bone mass. The most likely reason for decreased bone mass is;

- (A) Normal estrogen level in blood
- (B) Low PTH in blood
- (C) Low calcium in bones due to low estrogen
- (D) Increased progesterone in blood

**Q51** Match **List-I** with **List-II**.

List-I		List-II	
(A)	Ilium, Ischium, Pubis	(I)	Contractile muscle proteins
(B)	Actin and Myosin	(II)	Skull bones
(C)	Troponin and Tropomyosin	(III)	Coxal bone
(D)	Parietal and Occipital	(IV)	Regulatory muscle proteins

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

- (A) A-III, B-I, C-IV, D-II
- (B) A-I, B-III, C-IV, D-II
- (C) A-IV, B-III, C-I, D-II
- (D) A-III, B-IV, C-I, D-II

**Q52** Read the following statements carefully.

- I. The joints which allow limited movements are formed by joining of two bones with the help of dense fibrous connective tissue.
- II. Each thick filament is a polymerised protein formed by monomeric amino acids called meromyosins.
- III. M line is a structural protein that bisects the A band into two equal halves.
- IV. Muscles present in our thigh differs from muscles present in heart wall, as former exhibit multiple peripheral nuclei.
- V. Spleen and oesophagus are the organs that are not protected by rib cage.



Choose the options with **incorrect** statement/s only.

- (A) (I) only
- (B) (I), (II) and (II) only
- (C) (I), (II) and (IV) only
- (D) (I), (II) and (V)

**Q53** Identify the following statements as **true(T)** or **false(F)**.

- A. 11<sup>th</sup> and 12<sup>th</sup> pairs of ribs are bicephalic and are called floating ribs.
- B. Increased concentration of  $\text{Ca}^{2+}$  in sarcoplasm causes muscle contraction that cannot affect length of A band.
- C. Sponges have same structure involved in movement of food as well as in locomotion.
- D. Sphenoid and ethmoid bones are unpaired facial bones.

- (A) A-F; B-T; C-T; D-F
- (B) A-T; B-T; C-T; D-F
- (C) A-T; B-T; C-F; D-F
- (D) A-T; B-F; C-F; D-T

**Q54** Given below are two statements:

**Statement-I:** Myosin + ADP + Pi represents high energy state of myosin.

**Statement-II:** Binding of ATP to the myosin head is associated with breaking of cross bridge.

In the light of the above statements, choose the most appropriate answer from the options given below:

- (A) Statement I is correct but Statement II is incorrect.
- (B) Statement I is incorrect but Statement II is correct.
- (C) Both Statement I and Statement II are correct.
- (D) Both Statement I and Statement II are incorrect.

**Q55** P is a joint that allows movement in one plane only and shows *180 degrees* of movement. This type of joint is found in our body at elbow and *skull*.

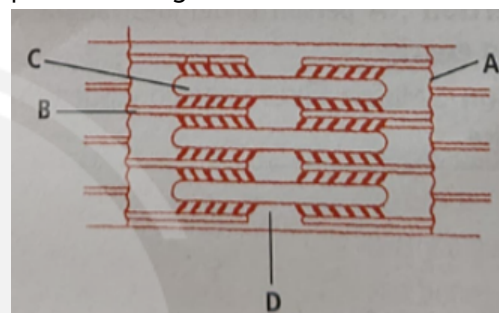
Q joint allows movement in all directions and in *more than* one plane. This joint controls the

movement of the humerus and *femur* bones.

Select the **incorrect** option regarding above comprehension.

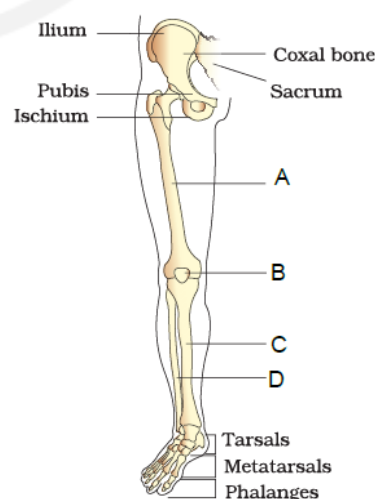
- (A) The joints in Q and P are ball and socket joint and hinge joint respectively.
- (B) Movement of pestle in a mortar resembles the movement of bones in Q joint.
- (C) *Skull* should be replaced by *knee* to make the statement correct.
- (D) P Joint resembles the movement of a clock hand.

**Q56** Which of the following is **true** for the labelled parts in the figure below:



- (A) A : Z line – Located at centre of I – band
- (B) B: Thin filament – Occurs in A-band only
- (C) C: Thick filament – Confined to I-band
- (D) D: H – Zone: Located at centre of M-line

**Q57** In the given diagram of the lower limb bones of a human, a sesamoid bone is depicted by the latter:



- (A) A
- (B) B
- (C) C
- (D) D



**Q58** Match **List-I** with **List-II**.

List-I		List-II	
(A)	Vertebrosteral ribs	(I)	Number of ear ossicles + Hyoid
(B)	Skull region	(II)	2
(C)	Number of tarsals per foot	(III)	7 pairs
(D)	Pelvic/Hip girdle	(IV)	22+6

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

- (A) A-III, B-I, C-IV, D-II
- (B) A-I, B-III, C-IV, D-II
- (C) A-IV, B-III, C-I, D-II
- (D) A-III, B-IV, C-I, D-II

**Q59** Choose the **incorrect** statement.

- (A) Last 2 pairs of ribs have no ventral attachment.
- (B)  $\text{Ca}^{+}$  ions are transported back to sarcoplasmic reticulum passively when muscle contraction gets over.
- (C) Humans have dicondylic skull and bicephalic ribs.
- (D) Acromian process is associated with scapula of pectoral girdle.

**Q60** Arrange the following steps in **correct** sequence for skeletal muscle contraction.

- A.  $[\text{Ca}^{+2}]$  gradually increases in sarcoplasm.
  - B. Calcium binds to troponin.
  - C. Troponin-tropomyosin move away from myosin binding sites on actin filaments.
  - D. Neural signal at neuromuscular junction releases Acetylcholine.
  - E. Action potential along sarcolemma.
  - F. Action-myosin cross-bridges formed
- (A) D → E → B → A → C → F
  - (B) D → E → A → B → C → F
  - (C) D → B → E → C → A → F
  - (D) D → B → A → C → E → F





## Answer Key

Q1 (C)  
Q2 (B)  
Q3 (C)  
Q4 (C)  
Q5 (A)  
Q6 (A)  
Q7 (B)  
Q8 (C)  
Q9 (B)  
Q10 (A)  
Q11 (D)  
Q12 (A)  
Q13 (A)  
Q14 (A)  
Q15 (B)  
Q16 (A)  
Q17 (D)  
Q18 (D)  
Q19 (C)  
Q20 (D)  
Q21 (A)  
Q22 (A)  
Q23 (D)  
Q24 (B)  
Q25 (C)  
Q26 (B)  
Q27 (A)  
Q28 (B)  
Q29 (C)  
Q30 (C)

Q31 (C)  
Q32 (C)  
Q33 (B)  
Q34 (A)  
Q35 (C)  
Q36 (A)  
Q37 (C)  
Q38 (A)  
Q39 (A)  
Q40 (A)  
Q41 (A)  
Q42 (A)  
Q43 (D)  
Q44 (B)  
Q45 (D)  
Q46 (B)  
Q47 (C)  
Q48 (C)  
Q49 (D)  
Q50 (C)  
Q51 (A)  
Q52 (D)  
Q53 (C)  
Q54 (C)  
Q55 (D)  
Q56 (A)  
Q57 (B)  
Q58 (D)  
Q59 (B)  
Q60 (B)



## Hints & Solutions

### Q1 Text Solution:

The mechanism of muscle contraction relies on a precise sequence of events. Upon neural stimulation, an action potential in the sarcolemma causes the release of calcium ions ( $\text{Ca}^{++}$ ) into the sarcoplasm from the sarcoplasmic reticulum.

These  $\text{Ca}^{++}$  ions are crucial as they bind to a subunit of troponin on the actin filaments, which then removes the masking of the active sites for myosin. Once these active sites are exposed, the myosin head, utilizing energy from ATP hydrolysis, can bind to actin to form a cross-bridge.

If the sarcoplasmic reticulum is depleted of  $\text{Ca}^{++}$  ions, even with abundant ATP, the troponin will not be able to unmask the active sites on actin. Therefore, the myosin head, despite being able to hydrolyze ATP, will not find exposed binding sites on actin and thus cannot form cross-bridges.

This prevents contraction. Rigor mortis is a state of muscle stiffness due to the inability of myosin heads to detach from actin in the absence of ATP, which is not the scenario here as ATP is abundant.

### Q2 Text Solution:

According to the sliding filament theory, muscle contraction occurs due to the sliding of thin (actin) filaments over thick (myosin) filaments. During shortening of the muscle (contraction), the 'I' bands get reduced, and the 'A' bands retain their length. The H zone, which is the central part of the 'A' band not overlapped by thin filaments in the resting state, also reduces and can disappear during maximal contraction as the thin filaments slide further inwards.

### Q3 Text Solution:

- Statement I is correct: Skeletal muscles have a striped appearance (striated), their activities

are under voluntary control, and they are primarily involved in locomotion and body posture changes.

- Statement II is correct: Visceral muscles do not exhibit any striation (smooth), are involuntary, and assist in processes like food transportation through the digestive tract.
- Statement III is incorrect: Cardiac muscles are indeed striated and involuntary, but the nervous system does not control their activities directly. They have their own intrinsic rhythmicity.
- Statement IV is correct: Muscle is a specialised tissue of mesodermal origin and muscles have special properties like excitability, contractility, extensibility and elasticity.

### Q4 Text Solution:

The axial skeleton comprises 80 bones distributed along the main axis of the body. The skull, vertebral column, sternum, and ribs constitute the axial skeleton.

P. Ribs: Part of the axial skeleton.

Q. Femur: Bone of the leg (hind limb), part of the appendicular skeleton.

R. Sternum: Part of the axial skeleton.

S. Carpals: Wrist bones, part of the appendicular skeleton (bones of the hand/fore limb).

T. Vertebral column: Part of the axial skeleton.

Therefore, P, R, and T correctly identify bones of the axial skeleton.

### Q5 Text Solution:

- Cells of human body exhibit three main types of movements, namely amoeboid, ciliary and muscular.
- Streaming of protoplasm in *Amoeba* is a simple form of movement, but not considered locomotion.
- In *Paramoecium*, cilia helps in the movement of food through cytopharynx and in locomotion as well.



- Locomotion is generally for search of food, shelter, mate, suitable breeding grounds, favourable climatic conditions or to escape from enemies/predators.

#### Q6 Text Solution:

- Statement I is correct: Repeated activation of muscles can lead to the accumulation of lactic acid due to anaerobic breakdown of glycogen, causing fatigue.
- Statement II is correct: Red fibres have high myoglobin content and plenty of mitochondria, enabling them to utilize large amounts of oxygen for ATP production, making them suited for aerobic activities.
- Statement III is correct: White fibres possess very less quantity of myoglobin, fewer mitochondria, and depend on anaerobic processes for energy.
- Statement IV is incorrect: The accumulation of lactic acid causing fatigue is reversible; with rest and sufficient oxygen, lactic acid can be converted back to pyruvate and utilized, or transported to the liver for gluconeogenesis. It does not lead to permanent damage under normal physiological conditions.

#### Q7 Text Solution:

- **A. Actin - ii. Forms the thin filament backbone:** Actin is the primary structural protein of the thin filament.
- **B. Myosin - i. Binds to ATP and has ATPase activity:** Myosin heads possess ATPase activity, which hydrolyzes ATP to provide energy for the power stroke.
- **C. Troponin - iv. Contains  $\text{Ca}^{2+}$  binding sites:** Troponin has a specific subunit (Troponin C) that binds to calcium ions, initiating the conformational change that exposes actin's binding sites.
- **D. Tropomyosin - iii. Covers myosin binding sites on actin:** In a relaxed state, tropomyosin coils around the actin filament, physically

blocking the active sites where myosin heads would bind.

#### Q8 Text Solution:

Fiber X, being reddish and suited for prolonged, sustained movements, corresponds to a red fibre (aerobic muscle), which has high myoglobin and plenty of mitochondria for aerobic ATP production. Fiber Y, being pale and involved in rapid, powerful bursts, corresponds to a White fibre (anaerobic muscle). White fibres depend on anaerobic processes for energy and possess very less quantity of myoglobin and fewer mitochondria. Crucially, White fibres have a *high* amount of sarcoplasmic reticulum. This extensive sarcoplasmic reticulum allows for rapid release and re-uptake of calcium ions, which is essential for the quick, powerful contractions characteristic of white fibers.

#### Q9 Text Solution:

Ciliary movement occurs in most of our internal 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.

#### Q10 Text Solution:

Muscles with characteristic striations and involuntary are muscles of the heart.

#### Q11 Text Solution:

Muscle contraction is initiated by a neural signal from the central nervous system via a motor neuron. The junction between a motor neuron and the sarcolemma of the muscle fiber is called the neuromuscular junction. A neural signal reaching this junction releases a neurotransmitter, Acetylcholine, which then generates an action potential in the sarcolemma. If the toxin blocks the release of neurotransmitters (Acetylcholine), the action potential generated by the motor neuron will not be transmitted across the neuromuscular junction to the sarcolemma. Consequently, no



action potential will be generated in the sarcolemma, and the entire cascade of events leading to muscle contraction (calcium release, cross-bridge formation) will not be initiated.

**Q12 Text Solution:**

Myasthenia gravis is indeed an autoimmune disorder where the body's immune system attacks and destroys the acetylcholine receptors at the neuromuscular junction. This reduces the ability of nerve impulses to trigger muscle contraction, leading to the symptoms described. However, it is not caused by a genetic mutation affecting acetylcholine production; rather, it's an attack on its receptors.

**Q13 Text Solution:**

Statement I is correct: Fibrous joints do not allow any movement and are shown by the flat skull bones which fuse end-to-end with the help of dense fibrous connective tissues.

Statement II is incorrect: Cartilaginous joints, such as the joint between adjacent vertebrae, permit limited movements, not considerable movement.

Statement III is correct: Synovial joints are characterized by a fluid-filled synovial cavity, allow considerable movement, and help in locomotion.

Statement IV is incorrect: The knee joint is a hinge joint, not a ball and socket joint. A ball and socket joint is exemplified by the joint between the humerus and pectoral girdle.

**Q14 Text Solution:**

Statement I is correct: Bone and cartilage are specialized connective tissues.

Statement II is correct: Bone has a very hard matrix due to calcium salts in it, and cartilage has a slightly pliable matrix due to chondroitin salts.

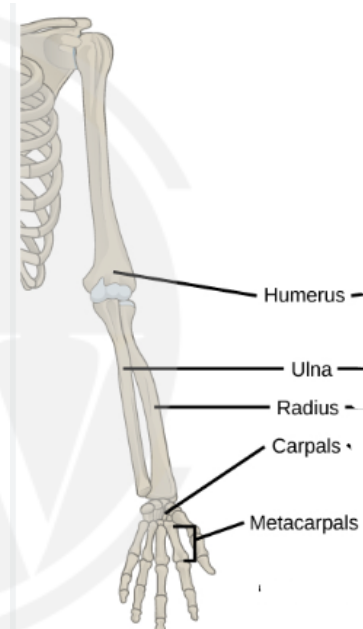
Statement III is incorrect: While the adult human skeletal system is made up of 206 bones, the number of bones is not fixed throughout life. Infants have more bones (around 300) which fuse during growth to reach the adult number of 206.

Statement IV is incorrect: A single U-shaped bone called hyoid is present at the base of the buccal cavity. However, it is not considered part of the facial skeleton. The facial region is made up of 14 skeletal elements, and the hyoid bone is distinct.

**Q15 Text Solution:**

Rigor mortis occurs not due to continuous formation of cross-bridges, but rather due to the inability of the existing cross-bridges to detach. After death, ATP is no longer produced, and since ATP is required to break the bond between actin and myosin, the muscles remain stiff.

**Q16 Text Solution:**



**Q17 Text Solution:**

All statements are anatomically correct descriptions of the vertebral column and thoracic cage. The total number of vertebrae (26 in adult due to fused sacrum and coccyx), the articulation of ribs, the structural differences in vertebrae based on function, and the definition of true ribs are all accurate.

**Q18 Text Solution:**

The frontal bone is clearly shown forming the forehead (anterior cranium) and superior part of the orbit.



The maxilla forms the upper jaw and contributes to the floor of the orbit.

The zygomatic bone (cheekbone) is depicted contributing to the lateral orbital wall.

The temporal bone contains the ear canal (external acoustic meatus) and articulates superiorly with the parietal bone.

**Q19 Text Solution:**

The mobility of these joints vary depending on different factors. Joints have been classified into three major structural forms, namely, fibrous, cartilaginous and synovial." It further elaborates on "Synovial joints" as having "a fluid filled lumen which have a considerable movement." Sprains typically involve ligaments that connect bones, and joints with a wide range of motion (like the ankle, which is a synovial joint) are most susceptible to such injuries. Fibrous and cartilaginous joints generally have limited or no movement.

**Q20 Text Solution:**

Tetany	Wild contractions in muscles
Myasthenia gravis	weakening and paralysis of skeletal muscle
Muscular dystrophy	Progressive degeneration of skeletal muscle due to genetic disorder
Osteoporosis	Decreased levels of estrogen

**Q21 Text Solution:**

- calcium ions must be removed from the sarcoplasm for relaxation. Pumping ions against their concentration gradient (back into the SR) requires active transport (energy). .
- During contraction, calcium binds to troponin, which exposes the binding sites, allowing myosin to bind. For relaxation, calcium is removed from troponin, causing tropomyosin to re-cover the binding sites, which prevents myosin from binding.

**Q22 Text Solution:**

- **Patella:** The kneecap, a sesamoid bone embedded within the quadriceps tendon .
- **Scapula:** The shoulder blade, a component of the pectoral girdle .
- **Atlas vertebra:** The first cervical vertebra, which articulates with the occipital condyles of the skull.
- **Ilium:** The largest and uppermost bone of the hip, forming a major part of the pelvic girdle

**Q23 Text Solution:**

A larger number of neuromuscular junctions per muscle (i.e., smaller motor units with fewer muscle fibers per motor neuron) indicates a higher degree of fine motor control. Each muscle fiber typically has only one neuromuscular junction. Fine control comes from the ability to recruit individual or small groups of motor units, not multiple junctions on a single fiber.

Osteoporosis leads to a decrease in bone mass and density, resulting from an imbalance between bone formation and resorption. Bones become porous and weak, not excessively rigid.

**Q24 Text Solution:**

Muscles are classified as Red and White fibres based primarily on the amount of red coloured myoglobin pigment in them.

**Q25 Text Solution:**

Last two pairs of ribs (11th and 12th) do not connect to the sternum. They are called floating ribs and offer protection to organs in the upper part of the abdominal cavity, like the kidneys.

**Q26 Text Solution:**

- **I. There is an increased concentration of lactate in the muscle cells, indicating a shift towards anaerobic respiration.** (Correct)  
During prolonged strenuous exercise like a marathon, oxygen supply may become insufficient, leading to anaerobic glycolysis and lactic acid accumulation, which contributes to muscle fatigue and pain.





- **II. The runner's red muscle fibers are predominantly active and experiencing a depletion of their glycogen stores.** (Correct) Long-distance running primarily engages slow-twitch (red) muscle fibers, which are rich in mitochondria and myoglobin, and rely heavily on aerobic respiration of glycogen and fats for sustained energy. Prolonged activity would lead to glycogen depletion.
- **III. There is a higher than normal concentration of creatine phosphate in the muscle, suggesting it's being rapidly re-synthesized.** (Incorrect) Creatine phosphate is a readily available source of energy for initial rapid ATP regeneration. During prolonged exercise and fatigue, creatine phosphate stores would be depleted rather than accumulating, as it's being used up to quickly regenerate ATP.
- **IV. The activity of Na<sup>+</sup>/K<sup>+</sup> pumps in the muscle cell membrane might be compromised, affecting repolarization.** (Correct) Intense and prolonged muscle activity can lead to an accumulation of extracellular potassium and depletion of intracellular sodium, which can impair the function of the Na<sup>+</sup>/K<sup>+</sup> pumps. This impairment can affect the muscle cell's ability to repolarize and conduct action potentials efficiently, contributing to fatigue.

#### Q27 Text Solution:

- **I. It would likely lead to stronger muscle contractions by increasing the number of active cross-bridges.** (Correct) More calcium in the sarcoplasm means more troponin binding, more active sites exposed, and thus more myosin heads forming cross-bridges, leading to stronger contractions.
- **II. The duration of muscle contraction would be shortened due to faster calcium reuptake.** (Incorrect) The problem states the drug prolongs calcium presence, which would

lengthen the duration of contraction, not shorten it.

- **III. The muscle would be more prone to tetanic contractions if stimulated rapidly.** (Correct) If calcium remains in the sarcoplasm for longer, and stimuli are rapid, the muscle will not have enough time to relax between stimuli, leading to summation and potentially tetanus.
- **IV. The drug primarily targets the release of acetylcholine at the neuromuscular junction.** (Incorrect) The question states the drug enhances calcium release from the sarcoplasmic reticulum, indicating its primary target is within the muscle cell itself, not at the neuromuscular junction.

#### Q28 Text Solution:

All locomotions are movements but all movements are not locomotions". For example, the movement of cilia in the trachea to clear dust is a movement, but not locomotion of the entire organism. locomotion is "voluntary movements [that] result in a change of place or location".

#### Q29 Text Solution:

The joint between the carpal (specifically, the trapezium) and the metacarpal of the thumb is a classic example of a **saddle joint**. This unique joint allows for a wide range of movements, including flexion, extension, abduction, adduction, circumduction, and opposition, which is crucial for the thumb's ability. (A) Hinge joints (e.g., knee, elbow) allow movement in one plane. (B) Gliding joints (e.g., between carpals) allow limited sliding movements. (D) Ball and socket joints (e.g., shoulder, hip) allow multi-axial movement, but the thumb's joint has a distinct saddle shape.

#### Q30 Text Solution:

The myosin head acts as an ATPase, hydrolyzing ATP into ADP and inorganic phosphate. This hydrolysis provides the energy for the myosin head to cock, bind to actin, and then pivot (power stroke), pulling the actin filament. While



creatine phosphate is an energy reserve and calcium is essential for unmasking binding sites, the direct energy for the power stroke comes from ATP hydrolysis at the myosin head. Calcium re-uptake is for relaxation.

**Q31 Text Solution:**

Fast muscle fibres	Quicker formation of lactic acid
Slow muscle fibres	High Myoglobin content
Anatomical unit	Muscle fibre
Sarcomere	Contractile unit

Fast-twitch fibres rely on anaerobic respiration, which leads to the production of lactic acid during intense activity. They are adapted for quick, powerful contractions, but fatigue quickly. Slow-twitch fibres are rich in myoglobin (oxygen-binding pigment), giving them a red color. Suited for endurance activities, they rely on aerobic respiration and have a delayed fatigue. A muscle fibre is a structural/anatomical unit of a muscle — a single multinucleated muscle cell. The sarcomere is the functional contractile unit of a striated muscle fibre, defined between two Z-lines.

**Q32 Text Solution:**

The head of the humerus articulates with the glenoid cavity of the scapula (part of the pectoral girdle), forming the glenohumeral joint, a classic ball-and-socket joint allowing multiaxial movement of the upper limb.

**Q33 Text Solution:**

Hypertrophy (muscle growth) increases lean body mass, which is denser than fat, explaining the weight gain despite fat reduction.

**Q34 Text Solution:**

Cardiac muscle fibres are uninucleate, not multinucleate (which is a feature of skeletal muscle). They do have intercalated discs, which help in electrical impulse conduction, but multinucleation is incorrect.

**Q35 Text Solution:**

The most likely combination of joints that would be badly affected in this accident are the synovial joints in the wrists and fibrous joint present between radius and ulna. These joints are designed for movement and would experience the maximum stress during the fall.

**Q36 Text Solution:**

Bones have a hard matrix due to calcium salts (like calcium phosphate); if this is deficient, bones become flexible or soft (as in rickets). Cartilage has a pliable matrix due to chondroitin sulfate; excess of this would make cartilage unusually rigid. These changes would disturb the mechanical function of the skeleton — support, protection, and locomotion — leading to poor posture, impaired movement, or joint issues.

**Q37 Text Solution:**

In myasthenia gravis, the hallmark symptom is progressive muscle weakness, especially with repeated use of the affected muscles. This is because sustained activity depletes available acetylcholine (ACh) in the synapse, while rest allows some recovery of neurotransmitter levels, leading to temporary improvement.

Myasthenia gravis is indeed an autoimmune disorder. The body produces autoantibodies against nicotinic ACh receptors on skeletal muscle at the neuromuscular junction (NMJ). This impairs synaptic transmission, leading to muscle weakness.

Blockage or destruction of ACh receptors mean less effective muscle stimulation. With activity, the limited functional receptors are quickly saturated, worsening weakness. With rest, the system partially recovers, improving function temporarily.

**Q38 Text Solution:**

Calcium ions ( $\text{Ca}^{2+}$ ) in the extracellular fluid play a crucial role in stabilizing neuronal membranes. They bind to voltage-gated sodium channels, reducing their excitability. Normal levels of



calcium maintain the threshold potential — the minimum depolarization required to trigger an action potential in a neuron.

Ionized calcium drops, removing the stabilizing effect on sodium channels. The threshold potential becomes more negative, moving closer to the RMP. Neurons become hyperexcitable, firing action potentials spontaneously or with minimal stimuli. This leads to increased muscle contractions, or tetany.

Acetylcholine synthesis is not significantly dependent on calcium levels. Calcium affects neurotransmitter release, but tetany is due to increased excitability, not decreased ACh production. Hypercalcemia actually depresses excitability (opposite effect). It raises threshold potential, making neurons less excitable. Tetany is not a feature of hypercalcemia, but of hypocalcemia.

Elevated calcium does not prevent repolarization. High calcium levels stabilize membranes, decreasing excitability. Sustained spasms (tetany) are not seen in hypercalcemia.

### Q39 Text Solution:

Creatine phosphate system is used immediately after muscle activity begins. It rapidly regenerates ATP but lasts only a few seconds and is anaerobic.

Anaerobic glycolysis kicks in next, especially when oxygen supply is insufficient (e.g., during intense activity). It yields 2 ATP per glucose and leads to lactic acid accumulation. Still anaerobic. Aerobic respiration is the most sustainable, used during prolonged moderate activity, but it requires oxygen and takes more time to become dominant. It is the main source of ATP during endurance activities.

Stage of Activity	Primary Source	Oxygen Needed	Duration
Immediate (0-10 sec)	Creatine phosphate	No	Very short
Short term (10-60 sec)	Anaerobic glycolysis	No	Short

Long term (1+ min)	Aerobic respiration	Yes	Sustained
--------------------	---------------------	-----	-----------

### Q40 Text Solution:

During intense exercise, oxygen supply is insufficient, so anaerobic glycolysis occurs in skeletal muscles. This leads to lactic acid buildup. After stopping, the body experiences an oxygen debt.

Extra oxygen taken in through rapid breathing helps:

Oxidize lactic acid back to pyruvate, which then enters the Krebs cycle.

Final byproducts:  $\text{CO}_2$  and  $\text{H}_2\text{O}$ , which are safely removed.

During exercise, ATP is rapidly consumed, not accumulated. The demand for ATP exceeds supply, especially in anaerobic conditions.

Breathing increases not because of ATP accumulation, but because of:

Oxygen needs

$\text{CO}_2$  removal

Restoration of ATP post-exercise

Calcium ions are involved in muscle contraction and relaxation, but they do not require oxygen for their movement directly. Oxygen's role is primarily in metabolism, not ion transport. Post-exercise oxygen is used to:

Replenish ATP and creatine phosphate

Break down lactic acid

Restore oxygen bound to myoglobin.

Myosin activation (cross-bridge cycling) depends on ATP and calcium, not directly on oxygen or post-exercise breathing. Breathing rate after exercise is unrelated to myosin activation in relaxed muscles. The purpose of increased breathing is metabolic recovery, not muscle activation.

### Q41 Text Solution:

Each vertebra has a vertebral foramen, and collectively, they form the neural canal, which encloses and protects the spinal cord.

The correct vertebral formula is:



- C7 – Cervical
- T12 – Thoracic
- L5 – Lumbar
- S5 (fused) – Sacral
- C4 (fused) – Coccygeal

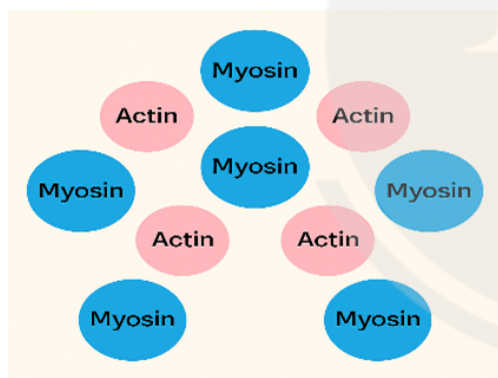
The H zone is indeed the central part of the A band where only thick filaments (myosin) are present. The M line lies in the center of the H zone and serves as the attachment site for thick filaments, not actin (thin filaments). Actin filaments are attached to the Z line, not the M line.

Ribs are called bicephalic because of two articulation surfaces at the dorsal end, not the ventral end:

- One articulates with the body of the vertebra.
- The other with the transverse process.

Ventral ends connect to the sternum and are not bicephalic.

#### Q42 Text Solution:



In the skeletal muscle sarcomere, the filaments are organized in a hexagonal pattern within the A-band, where:

- Each myosin (thick) filament is surrounded by 6 actin (thin) filaments.
- Each actin filament is surrounded by 3 myosin filaments.

This arrangement is crucial for cross-bridge formation during muscle contraction.

#### Q43 Text Solution:

The human vertebral column consists of 33 vertebrae in total, but only 26 remain as separate

bones in adults because some (like the sacral and coccygeal vertebrae) fuse together. Therefore, while 33 is the correct number of vertebrae, not bones.

The troponin-tropomyosin complex does not regenerate ATP. Instead, this complex plays a regulatory role in muscle contraction by blocking or exposing the myosin-binding sites on actin, depending on the presence of calcium ions. ATP is regenerated through cellular respiration, not by this complex.

The sarcolemma is the specialized cell membrane of muscle fibers, while the sarcoplasmic reticulum (SR) is the specialized ER that stores and releases  $\text{Ca}^{2+}$  ions needed for muscle contraction.

When  $\text{Ca}^{2+}$  concentration is low, the troponin-tropomyosin complex blocks the myosin-binding site on actin, preventing contraction. When  $\text{Ca}^{2+}$  concentration rises, calcium binds to troponin, causing the complex to shift, exposing the binding site, and allowing cross-bridge formation between actin and myosin.

#### Q44 Text Solution:

- When  $\text{Ca}^{2+}$  binds to Troponin C, it induces a shape change in the entire complex.
- This change relieves the inhibitory effect of Troponin I on actin.
- Tropomyosin shifts away from myosin-binding sites on actin → cross-bridge cycling begins.

Troponin Subunit	Function
Troponin T (TnT)	Anchors the troponin complex to tropomyosin
Troponin I (TnI)	Inhibits the actin-myosin interaction in the absence of $\text{Ca}^{2+}$
Troponin C (TnC)	Binds $\text{Ca}^{2+}$ during muscle activation → causes conformational change that lifts TnI inhibition

#### Q45 Text Solution:



Rigor mortis is the post-mortem stiffening of muscles due to lack of ATP. In living muscle, ATP is needed to detach myosin heads from actin filaments during the relaxation phase of contraction.

When ATP is absent, the myosin heads remain bound to actin, leading to a state of permanent contraction (rigor). This is not an active contraction but a passive, biochemical lock of the muscle fibers.

**Q46 Text Solution:**

In tetanisation, stimuli are so frequent that calcium ions remain in the sarcoplasm, and relaxation is prevented. This leads to sustained high tension — seen as a flat plateau on the graph.

**Q47 Text Solution:**

- **A.** Atlas is the first cervical vertebra, not thoracic.
- **B.** Acetabulum is part of the pelvic girdle, not femur; it receives the head of femur, not humerus.
- **C.** Glenoid cavity is part of scapula; forms ball-and-socket joint with head of humerus.
- **D.** Tibia is the medial and larger bone of the lower leg; fibula is the thinner, lateral one.

**Q48 Text Solution:**

Statement	Correct	Explanation
1	True	Atlas–occipital condyle forms a condyloid joint → enables “yes” nodding (flexion/extension).
2	True	Atlas–axis joint is a pivot joint → allows rotation, i.e., “no” movement of the head.
3	True	Elbow is a hinge joint → uniaxial movement (flexion & extension).

4	False	Pubic symphysis is a cartilaginous joint, not synovial; allows limited movement, not wide.
5	True	Sutures of the skull are fibrous joints → immovable (synarthrosis).

**Q49 Text Solution:**

Fast-oxidative-glycolytic fibres are an intermediate type that are designed to contract rapidly but to resist fatigue. They utilise both aerobic and anaerobic energy systems, thus they are red fibres with high myoglobin (which facilitates production of ATP by oxidative phosphorylation), but they also have a moderate ability to generate ATP through glycolytic pathways.

**Q50 Text Solution:**

After menopause, low levels of estrogen is a common cause of osteoporosis which leads to fracture of bones.

**Q51 Text Solution:**

- Ilium, ischium and pubis, fuse to form coxal bone.
- Actin and myosin are contractile muscle proteins.
- Troponin and tropomyosin are regulatory muscle proteins.
- Parietal and occipital are skull bones.

**Q52 Text Solution:**

Fibrous joints (like sutures of the skull) involve dense fibrous connective tissue and are immovable (synarthrosis). Joints that allow limited movement are cartilaginous joints, where bones are joined by cartilage (e.g., pubic symphysis, intervertebral discs). So, this statement incorrectly describes the type of tissue involved in limited movement joints. Myosin (thick filament) is a polymer of myosin molecules, not of monomeric amino acids called





meromyosins. In fact, each myosin molecule has two parts:

- Heavy meromyosin (HMM) – forms the head and short arm
- Light meromyosin (LMM) – forms the tail

So, meromyosin is a structural component of the myosin molecule, not a monomeric amino acid. The M line runs through the center of the A band (within the H zone).

It holds the thick (myosin) filaments in place and serves as the midline of the sarcomere.

Skeletal muscle fibers (like those in the thigh) are:

- Multinucleated
- Have peripherally located nuclei

Cardiac muscles are:

- Uninucleate or binucleate
- Have centrally located nuclei

The spleen lies in the left upper quadrant of the abdomen and is partially protected by the lower ribs (typically ribs 9–11). The esophagus (upper part) passes through the thoracic cavity, which is within the rib cage. Hence, both spleen and esophagus are at least partially protected by the rib cage, making this statement false.

### Q53 Text Solution:

The 11th and 12th pairs of ribs are indeed floating ribs because they do not attach to the sternum. However, bicephalic means “two-headed” – ribs with two articulating surfaces at the dorsal end (head and tubercle). All typical ribs are bicephalic, but the floating ribs lack ventral articulation.

Muscle contraction is initiated when  $\text{Ca}^{2+}$  levels rise in the sarcoplasm. This allows actin-myosin cross-bridge formation. A band corresponds to the entire length of thick filaments (myosin) and does not change length during contraction.

Instead, I band and H zone shorten.

Choanocytes help in food capturing but not in locomotion.

Sphenoid and ethmoid are indeed unpaired, but they are cranial bones, not facial bones.

Facial bones include maxilla, mandible, nasal, zygomatic, etc.

### Q54 Text Solution:

When ATP binds to the myosin head, it is hydrolyzed to ADP + Pi.

This hydrolysis energizes the myosin head, causing it to enter a high-energy conformation, ready to bind actin. So, the myosin-ADP-Pi complex is indeed in its high-energy state. After the power stroke, the myosin head remains attached to actin in a low-energy state. For the cross-bridge to detach, a new ATP molecule must bind to the myosin head. ATP binding leads to detachment of the myosin head from actin — i.e., breaking the cross-bridge. This is a key regulatory step in the contraction-relaxation cycle.

### Q55 Text Solution:

P joint:

- Allows movement in one plane
- Shows 180° movement
- Found at elbow and knee  
→ Clearly describes a hinge joint

Q joint:

- Allows movement in multiple directions and planes
- Controls movement of humerus and femur  
→ Clearly describes a ball and socket joint (shoulder and hip)

Pestle moves in all directions within the bowl — a good analogy for ball and socket joint, which permits movement in multiple planes.

Passage says “P joint is found at elbow and skull”, but:

- Skull joints (like sutures) are fibrous and immovable.
- Knee is a hinge joint, just like elbow.
- So, replacing skull with knee makes it accurate.



A clock hand moves in a circular plane (rotation). Hinge joints (like elbow) allow flexion and extension only in a single plane (like a door hinge), not circular motion. Therefore, this analogy is incorrect.

**Q56 Text Solution:**

A - Z line: Located at centre of I – band

B – Thin filament: Occurs in both I – band and A-band

C – Thick filament: Occurs in A – band

D – H – Zone: present at the centre of A- band

**Q57 Text Solution:**

The patella is the largest sesamoid bone in the human body. Sesamoid bones are embedded within tendons. The patella is located within the quadriceps tendon and functions to protect the knee joint and improve leverage of thigh muscles.

**Q58 Text Solution:**

Vertebrosteral ribs → (iii) 7 pairs

- Also known as true ribs, these are the first 7 pairs that connect directly to the sternum.

The skull has:

- 22 cranial and facial bones
- 6 ear ossicles (3 in each ear)
- Total:  $22 + 6 = 28$

Tarsals per foot = 7

Ear ossicles: 6 total

Hyoid: 1

So,  $6 + 1 = 7$  → Matches the number of tarsals

The hip girdle consists of 2 hip bones (coxal bones) — one on each side.

**Q59 Text Solution:**

Last 2 pairs of ribs have no ventral attachment and these are known as floating ribs (ribs 11 and 12). They do not attach to the sternum at all — not even indirectly.

Calcium ions ( $\text{Ca}^{2+}$ ) are transported back into the sarcoplasmic reticulum (SR) actively, using ATP-dependent calcium pumps (SERCA pumps).

Passive transport does not occur for this process.

Dicondylic skull: Human skull articulates with the vertebral column via two occipital condyles.

Bicephalic ribs: Each rib has two articulating surfaces (heads) to connect with the thoracic vertebrae.

The acromion is a bony projection of the scapula. It forms the highest point of the shoulder and is part of the pectoral girdle.

**Q60 Text Solution:**

D – Neural signal at neuromuscular junction releases Acetylcholine → This initiates the signal to the muscle.

E – Action potential along sarcolemma → The signal travels along the muscle membrane.

A –  $[\text{Ca}^{2+}]$  gradually increases in sarcoplasm → Due to opening of calcium channels in sarcoplasmic reticulum.

B – Calcium binds to troponin → Leading to structural changes in regulatory proteins.

C – Troponin-tropomyosin complex moves away from myosin binding sites on actin → Myosin binding sites on actin are exposed.

F – Actin-myosin cross-bridges are formed → Leading to muscle contraction.



[Android App](#)

| [iOS App](#)

| [PW Website](#)