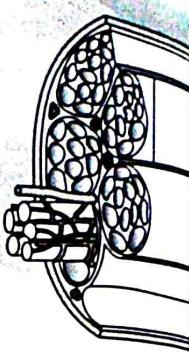


# 17 Locomotion and Movement



## 17.2. Muscle

1. Select the correct statements regarding mechanism of muscle contraction.

- It is initiated by a signal sent by CNS via sensory neuron.
- Neurotransmitter generates action potential in the sarcolemma.
- Increased  $\text{Ca}^{++}$  level leads to the binding of calcium with troponin on actin filaments.
- Masking of active site for actin is activated.
- Utilising the energy from ATP hydrolysis to form cross bridge.

Choose the most appropriate answer from the options given below:

- (II), (III) and (V) only
- (III), (IV) and (V) only
- (I) and (IV) only
- (II), (IV) and (V) only

[Re-NEET 2024]

2. Which of the following statements are correct regarding skeletal muscle?

- Muscle bundles are held together by collagenous connective tissue layer called fascicle.
- Sarcoplasmic reticulum of muscle fibre is a store house of calcium ions.
- Striated appearance of skeletal muscle fibre is due to distribution pattern of actin and myosin proteins.
- M line is considered as functional unit of contraction called sarcomere.

Choose the most appropriate answer from the options given below:

- (I), (III) and (IV) only
- (III) and (IV) only
- (I), (II) and (III) only
- (II) and (III) only

[NEET 2023]

3. During muscular contraction which of the following events occur?

- 'H' zone disappears
- 'A' band widens
- 'I' band reduces in width

- Myosin hydrolyzes ATP, releasing the ADP and  $\text{P}_i$
- Z-lines attached to actins are pulled inwards

Choose the correct answer from the options given below.

- (I), (III), (IV), (V) only
- (I), (II), (III), (IV) only
- (II), (III), (IV), (V) only
- (II), (IV), (V), (I) only

[NEET 2021]

4. Calcium is important in skeletal muscle contraction because it:

- detaches the myosin head from the actin filament
- activates the myosin ATPase by binding to it
- binds to troponin to remove the masking of active sites on actin for myosin @THE\_RDX\_07
- prevents the formation of bonds between the myosin cross bridges and the actin filament.

[NEET 2018]

5. Lack of relaxation between successive stimuli in sustained muscle contraction is known as:

- fatigue
- tetanus
- tonus
- spasm

[NEET Phase-I 2016]

6. Smooth muscles are:

- involuntary, fusiform, non-striated
- voluntary, multinucleate, cylindrical
- involuntary, cylindrical, striated
- voluntary, spindle-shaped, uninucleate

[NEET Phase-II 2016]

7. Sliding filament theory can be best explained as:

- Actin and myosin filaments do not shorten but rather slide pass each other
- When myofilaments slide pass each other myosin filaments shorten, while actin filaments do not shorten
- When myofilaments slide pass each other actin filaments shorten, while myosin filament do not shorten
- Actin and myosin filaments shorten and slide pass each other.

[AIPMT 2015]

8. Stimulation of a muscle fibre by a motor neuron occurs at:

- (A) the neuromuscular junction
- (B) the transverse tubules
- (C) the myofibril
- (D) the sarcoplasmic reticulum

[AIPMT 2014]

9. The H-zone in the skeletal muscle fibre is due to:

- (A) the absence of myofibrils in the central portion of A-band
- (B) the central gap between myosin filaments in the A-band
- (C) the central gap between actin filaments extending through myosin filaments in the A-band
- (D) extension of myosin filaments in the central portion of the A-band

[NEET 2013]

10. The type of muscle present in our:

- (A) heart is involuntary and unstriated smooth muscle
- (B) intestine is striated and involuntary
- (C) thigh is striated and voluntary
- (D) upper arm is smooth muscle and fusiform in shape

[AIPMT 2011]

11. Which statement is correct for muscle contraction?

- (A) Length of H-zone decrease
- (B) Length of A-band remains constant
- (C) Length of I-band increases
- (D) Length of two Z-line increases

[AIPMT 2001]

12. What is sarcomere?

- (A) Part between two H-lines
- (B) Part between two A-lines
- (C) Part between two I-bands
- (D) Part between two Z-lines

[AIPMT 2001]

13. The functional unit of contractile system in striated muscle is:

- (A) myofibril
- (B) sarcomere
- (C) Z-lines
- (D) cross bridges.

[AIPMT 1998]

14. Which of the following is the contractile protein of a muscle?

- (A) Tubulin
- (B) Tropomyosin
- (C) Myosin
- (D) All the above

[AIPMT 1998]

15. When a muscle bends one part upon the other, it is called:

- (A) abductor
- (B) regulator
- (C) extensor
- (D) flexor.

[AIPMT 1996]

### 17.3. Skeletal System

16. Match the following columns and select the correct option.

Column I	Column II
(a) Floating ribs	(i) Located between second and seventh ribs
(b) Acromion	(ii) Head of the humerus
(c) Scapula	(iii) Clavicle
(d) Glenoid cavity	(iv) Do not connect with the sternum

Select the correct option.

- (a) (b) (c) (d)
- (A) (i) (iii) (ii) (iv)
- (B) (iii) (ii) (iv) (i)
- (C) (iv) (iii) (i) (ii)
- (D) (ii) (iv) (i) (iii)

[NEET Sept. 2020]

17. Select the correct option.

- (A) 11<sup>th</sup> and 12<sup>th</sup> pairs of ribs are connected to the sternum with the help of hyaline cartilage.
- (B) Each rib is a flat thin bone and all the ribs are connected dorsally to the thoracic vertebrae and ventrally to the sternum.
- (C) There are seven pairs of vertebrosternal, three pairs of vertebrochondral and two pairs of vertebral ribs.
- (D) 8<sup>th</sup>, 9<sup>th</sup> and 10<sup>th</sup> pairs of ribs articulate directly with the sternum.

[NEET National 2019]

18. Out of 'X' pairs of ribs in humans only 'Y' pairs are true ribs. Select the option that correctly represents values of X and Y and provides their explanation.

Column I	Column II
(A) X = 12, Y = 7	(I) True ribs are attached dorsally to vertebral column and ventrally to the sternum.
(B) X = 12, Y = 5	(II) True ribs are attached dorsally to vertebral column and sternum on the two ends.
(C) X = 24, Y = 7	(III) True ribs are dorsally attached to vertebral column, but are free on ventral side.
(D) X = 24, Y = 12	(IV) True ribs are dorsally attached to vertebral column, but are free on ventral side.

[NEET 2017]

19. Glenoid cavity articulates:

- clavicle with acromion
- scapula with acromion
- clavicle with scapula
- humerus with scapula

[AIPMT Cancelled 2015]

20. Which of the following is not a function of the skeletal system?

- Production of erythrocytes
- Storage of minerals
- Production of body heat
- Locomotion

[AIPMT Latest July 2015]

21. Three of the following pairs of the human skeletal parts are correctly matched with their respective inclusive skeletal category and one pair is not matched. Identify the non-matching pair.

Pairs of skeletal parts	Category
(A) Sternum and ribs	Axial skeleton
(B) Clavicle and glenoid cavity	Pelvic girdle
(C) Humerus and ulna	Appendicular skeleton
(D) Malleus and stapes	Ear ossicles

[AIPMT Mains 2012]

22. Which one of the following item gives its correct total number?

- Floating ribs in humans — 4
- Amino acids found in proteins — 16
- Types of diabetes — 3
- Cervical vertebrae in humans — 8

[AIPMT Screening 2008]

23. An acromion process is characteristically found in the:

- pelvic girdle of mammals
- pectoral girdle of mammals
- skull of frog
- sperm of mammals

[AIPMT 2005]

24. Which cartilage is present at the end of long bones?

- Calcified cartilage
- Hyaline cartilage
- Elastic cartilage
- Fibrous cartilage

[AIPMT 2002]

25. What will happen if ligaments are cut or broken?

- Bones will move freely at joints.
- No movement at joints.
- Bone will become unfix.
- Bone will become fixed.

[AIPMT 2002]

26. Bone related with skull is:

- coracoid
- arytenoid
- pterygoid
- atlas.

[AIPMT 2000]

27. Sternum is connected to ribs by:

- bony matter
- white fibrous cartilage
- hyaline cartilage
- areolar tissue

[AIPMT 2000]

28. Total number of bones in the hind limb of man is:

- 14
- 30
- 24
- 21

[AIPMT 1998]

29. The number of floating ribs, in the human body, is:

- 6 pairs
- 5 pairs
- 3 pairs
- 2 pairs.

[AIPMT 1995]

30. Which is a part of pectoral girdle?

- Glenoid cavity
- Sternum
- Ileum
- Acetabulum

[AIPMT 1994]

31. Long bones function in:

- support
- support, erythrocyte and leucocyte synthesis
- support and erythrocyte synthesis
- erythrocyte formation

[AIPMT 1993]

32. The cervical vertebrae in humans is:

- same as in whale
- more than that in rabbit
- double than that of horse
- less than that in giraffe.

[AIPMT 1993]

33. A deltoid ridge occurs in:

- radius
- ulna
- femur
- humerus

[AIPMT 1990]

## 17.4. Joints

34. Match List-I with List-II:

List-I (Location of Joint)	List-II (Type of Joint)
(a) Joint between humerus and pectoral girdle	(i) Gliding joint
(b) Knee joint	(ii) Ball and Socket joint
(c) Joint between atlas and axis	(iii) Hinge joint
(d) Joint between carpals	(iv) Pivot joint

Choose the correct answer from the options given below:

(a)	(b)	(c)	(d)
(A) (ii)	(iii)	(iv)	(i)
(B) (iii)	(ii)	(i)	(iv)
(C) (i)	(iv)	(iii)	(ii)
(D) (ii)	(i)	(iii)	(iv)

[Re-NEET 2024]

35. Match List I with List II:

List I	List II
(a) Fibrous joints	(i) Adjacent vertebrae, limited movement
(b) Cartilaginous joints	(ii) Humerus and Pectoral girdle, rotational movement
(c) Hinge joints	(iii) Skull, don't allow any movement
(d) Ball and socket joints	(iv) Knee, help in locomotion

Choose the correct answer from the options given below:

(a) (b) (c) (d)  
 (A) (i) (iii) (ii) (iv)  
 (B) (ii) (iii) (i) (iv)  
 (C) (iii) (i) (iv) (ii)  
 (D) (iv) (ii) (iii) (i) [NEET 2024]

36. Match List I with List II:

List I (Type of Joint)	List II (Found between)
(a) Cartilaginous Joint	(i) Between flat skull bones
(b) Ball and Socket Joint	(ii) Between adjacent vertebrae in vertebral column
(c) Fibrous Joint	(iii) Between carpal and metacarpal of thumb
(d) Saddle Joint	(iv) Between Humerus and Pectoral girdle

Choose the correct answer from the options given below:

(a) (b) (c) (d)  
 (A) (i) (iv) (iii) (ii)  
 (B) (ii) (iv) (iii) (i)  
 (C) (iii) (i) (ii) (iv)  
 (D) (ii) (iv) (i) (iii) [NEET 2023]

37. Match List-I with List-II.

List-I	List-II
(a) Scapula	(i) Cartilaginous joints
(b) Cranium	(ii) Flat bone
(c) Sternum	(iii) Fibrous joints
(d) Vertebral column	(iv) Triangular flat bone

Choose the correct answer from the options given below:

(a) (b) (c) (d)  
 (A) (i) (iii) (ii) (iv)  
 (B) (ii) (iii) (iv) (i)  
 (C) (iv) (ii) (iii) (i)  
 (D) (iv) (iii) (ii) (i) [NEET 2021]

38. Match the following joints with the bones involved.

Column I	Column II
(a) Gliding joint	(i) Between carpal and metacarpal of thumb
(b) Hinge joint	(ii) Between atlas and axis
(c) Pivot joint	(iii) Between the carpal
(d) Saddle joint	(iv) Between humerus and ulna

Select the correct option from the following.

(a) (b) (c) (d)  
 (A) (iii) (iv) (ii) (i)  
 (B) (iv) (i) (ii) (iii)  
 (C) (iv) (ii) (iii) (i)  
 (D) (i) (iii) (ii) (iv) [NEET Odisha 2019]

39. The pivot joint between atlas and axis is a type of:

(A) fibrous joint (B) cartilaginous joint  
 (C) synovial joint (D) saddle joint [NEET 2017]

40. Which of the following joints would allow no movement?

(A) Fibrous joint (B) Cartilaginous joint  
 (C) Synovial joint (D) Ball and socket joint

[AIPMT Latest July 2015]

41. Select the correct matching of the type of the joint with the example in human skeletal system.

Types of joint	Example
(A) Cartilaginous joint	(I) Between frontal and parietal
(B) Pivot Joint	(II) Between third and fourth cervical vertebrae
(C) Hinge Joint	(III) Between humerus and pectoral girdle
(D) Gliding joint	(IV) Between carpal

[AIPMT 2014]

42. The characteristics and an example of a synovial joint in humans is:

Characteristics	Examples
(A) Fluid cartilage between two bones, limited movements	Knee joints
(B) Fluid filled between two joints, provides cushion	Skull bones
(C) Fluid filled synovial cavity between two bones	Joint between atlas and axis
(D) Lymph filled between two bones, limited movements	Gliding joint between carpal

[NEET 2013]

43. Which one of the following is the correct description of a certain part of a normal human skeleton?

(A) Parietal bone and the temporal bone of the skull are joined by fibrous joint.  
 (B) First vertebra is axis, which articulates with the occipital condyles.

(C) The 9<sup>th</sup> and 10<sup>th</sup> pairs of ribs are called the floating ribs.  
 (D) Glenoid cavity is a depression to which the thigh bone articulates. [AIPMT Mains 2010]

44. Elbow joint is an example of:  
 (A) pivot joint  
 (B) hinge joint  
 (C) gliding joint  
 (D) ball and socket joint [AIPMT Screening 2009]

45. Which of the following pairs, is correctly matched?  
 (A) Hinge joint — between vertebrae  
 (B) Gliding joint — between zygapophyses of the successive vertebrae  
 (C) Cartilaginous joint — skull bones  
 (D) Fibrous joint — between phalanges [AIPMT 2005]

46. The joint found between sternum and the ribs in humans is:  
 (A) angular joint (B) fibrous joint  
 (C) cartilaginous joint (D) gliding joint [AIPMT 2000]

47. The joint between the atlas and axis is called as:  
 (A) Saddle joint (B) Hinge joint  
 (C) Pivot joint (D) Angular joint [AIPMT 1999]

48. Given below are two statements one is labelled as Assertion (A) and the other is labelled as Reason (R).  
**Assertion (A):** Osteoporosis is characterised by decreased bone mass and increased chances of fractures.  
**Reason (R):** Common cause of osteoporosis is increased levels of estrogen.  
 In the light of the above statements choose the most appropriate answer from the options given below:  
 (A) Both (A) and (R) are correct but (R) is not the correct explanation of (A).  
 (B) (A) is correct but (R) is not correct.

(C) (A) is not correct but (R) is correct.  
 (D) Both (A) and (R) are correct and (R) is the correct explanation of (A). [NEET 2022]

49. Which of the following is a correct match for disease and its symptoms?  
 (A) Tetany – high  $\text{Ca}^{2+}$  level causing rapid spasms  
 (B) Myasthenia gravis – Genetic disorder resulting in weakening and paralysis of skeletal muscle  
 (C) Muscular dystrophy – An autoimmune disorder causing progressive degeneration of skeletal muscle  
 (D) Arthritis – Inflamed joints [NEET 2022]

50. Which of the following muscular disorders is inherited?  
 (A) Muscular dystrophy (B) Myasthenia gravis  
 (C) Botulism (D) Tetany [NEET National 2019]

51. Osteoporosis, an age-related disease of skeletal system, may occur due to:  
 (A) immune disorder affecting neuromuscular junction leading to fatigue.  
 (B) high concentration of  $\text{Ca}^{++}$  and  $\text{Na}^+$ .  
 (C) decreased level of oestrogen.  
 (D) accumulation of uric acid leading to inflammation of joints. [NEET Phase-II 2016]

52. Select the correct statement with respect to locomotion in humans.  
 (A) A decreased level of progesterone causes osteoporosis in old people.  
 (B) Accumulation of uric acid crystals in joints causes their inflammation.  
 (C) The vertebral column has 10 thoracic vertebrae.  
 (D) The joint between adjacent vertebrae is a fibrous joint. [NEET 2013]

53. Select the correct statement regarding the specific disorder of muscular or skeletal system.  
 (A) Muscular dystrophy - age related shortening of muscles  
 (B) Osteoporosis - decrease in bone mass and higher chances of fractures with advancing age  
 (C) Myasthenia gravis - auto immune disorder which inhibits sliding of myosin filaments  
 (D) Gout - inflammation of joints due to extra deposition of calcium [AIPMT Screening 2012]

## SOLUTIONS

1. (A) The mechanism of muscle contraction involves several key steps:  
 Muscle contraction is initiated by a signal sent by the CNS via a motor neuron, not a sensory neuron. A neural signal releases a neurotransmitter (acetylcholine) at the neuromuscular junction,

generating an action potential in the sarcolemma. The action potential causes the release of calcium ions into the sarcoplasm, which bind to troponin on actin filaments, removing the masking of active sites for myosin. The binding of calcium to troponin removes the masking of active sites on actin,

allowing myosin to bind. Myosin heads utilise energy from ATP hydrolysis to bind to exposed active sites on actin, forming cross bridges and leading to muscle contraction.

2. (D) Muscle bundles in skeletal muscle are actually held together by a layer of common collagenous connective tissue layer called fascia, not fascicle. Fascicle refers to a bundle of muscle fibers within the muscle.

The functional unit of contraction in skeletal muscle is the sarcomere, not the M line. The M line is a structure in the center of the sarcomere that helps to anchor the myosin filaments in place during contraction.

3. (A) Muscle contraction is brought about by sliding of the actin filaments over myosin filaments. During the process of muscular contraction, the myosin head binds to the exposed active sites on actin to form a cross bridge. This pulls the attached actin filaments to the centre of the 'A' band. The 'Z' line attached to these actins is also pulled inwards, causing the sarcomere to shorten, *i.e.*, contract. The preceding steps demonstrate that during muscle shortening, *i.e.*, contraction, the 'T' bands shorten, while the 'A' bands retain the length and the size of 'H' zone becomes smaller and it disappears. Myosin returns to its relaxed state after releasing ADP and Pi by the hydrolysis of ATP.

4. (C) During muscle contraction, tropomyosin changes conformation, uncovering the myosin-binding site on an actin molecule and allowing cross-bridge formation in the presence of calcium, which is kept at extremely low concentrations in the sarcoplasm. Calcium ions bound to troponin causes conformational changes in troponin that allow tropomyosin to move away from the myosin binding sites on actin. Once the tropomyosin is removed, a cross-bridge can form between actin and myosin, triggering contraction. Cross-bridge cycling continues until  $\text{Ca}^{2+}$  ions and ATP are no longer available and tropomyosin again covers the binding sites on actin.



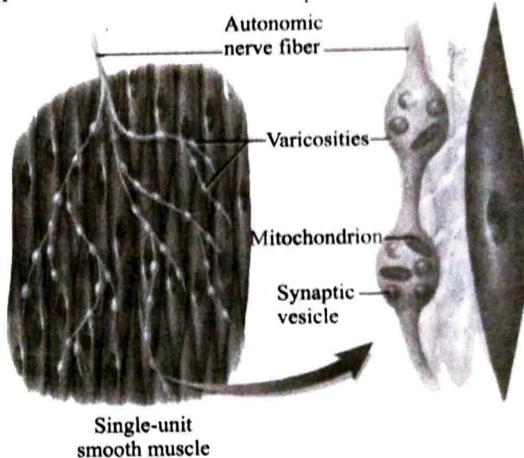
### Related Theory

When a muscle is in a resting state, actin and myosin are separated. To prevent actin from binding to the active site on myosin, regulatory proteins block the molecular binding sites. Tropomyosin blocks myosin binding sites on actin molecules, preventing cross-bridge formation and also preventing contraction in a muscle without nervous input. Troponin binds to tropomyosin and helps to position it on the actin molecule; it also binds calcium ions.

5. (B) Tetanus is a disease characterised by a lack of relaxation between successive stimuli during sustained muscle contraction. Tetanus is a bacterial

infection caused by the bacterium *Clostridium tetani*. This bacterium causes the release of a neurotoxin, which causes an increase in muscle contraction, resulting in a very painful condition. Fatigue, on the other hand, refers to the sensation of being overtired and having low energy. Muscle tonus is a reduction in muscle activity caused by partial muscle contraction. Spasms are painful muscular contractions that can occur as a result of over-exercising, stress, or dehydration.

6. (A) Smooth muscles are found in the inner walls of hollow visceral organs, such as the alimentary canal, reproductive tract, and so on. They have no striation and are smooth in appearance. As a result, they are known as smooth muscles (non-striated muscles). As their activities are not under the control of the nervous system, they are referred to as involuntary muscles. Smooth muscle fibres are uninucleated, fusiform (tapered at both ends) that are arranged in parallel lines to form sheets.



Smooth Muscles

7. (A) When a muscle contracts, the thick and thin filaments of sarcomeres slide by one another, causing the sarcomere to shorten, while the filaments remain the same length. Contraction of the muscles is the shortening of myofibrils in response to nervous stimulation, during which actin filaments slide over myosin filaments and link with them, resulting in the formation of actomyosin complexes. When a muscle contracts, the distance between the Z lines becomes narrow. During contraction, the H zone contains only thick filaments and the I band contains only thin filaments. The length of the A band does not change and remains constant.

8. (A) A signal sent by the central nervous system (CNS) via a motor neuron causes muscle contraction. The neuromuscular junction is the junction between a motor neuron and a muscle fiber's sarcolemma. When a neural signal reaches this junction, it causes a neurotransmitter (Acetylcholine) to be released,

which stimulates the muscle fibre by causing an action potential to be generated in the sarcolemma. Hence, a motor neuron stimulates a muscle fibre at the neuromuscular junction.

9. (C) Myofibril is composed of two kinds of filaments. They are thin filaments (actin) and thick filaments (myosin). The light bands, known as 'I' bands or isotropic bands contain actin, whereas the dark bands, known as 'A' bands or anisotropic bands, contain myosin. The 'A' and 'I' bands are alternately arranged along the length of the myofibrils. In a resting state, the edges of the thin filaments on either side of the thick filaments partially overlap the free ends of the thick filaments, leaving the thick filaments' central part exposed. The 'H' zone refers to that central part of thick filament, which is not overlapped by thin filaments. As a result, the 'H' zone in skeletal muscle fibre is due to central gap between actin filaments that extends through myosin filaments in the A-band.

#### Caution

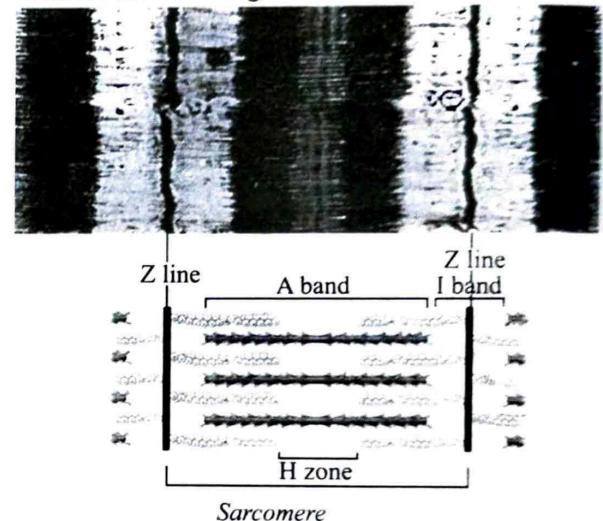
- Students often get confused between the 'A' (dark bands) and 'I' bands (light bands). Remember that word 'Dark' starts with alphabets 'D' and 'A'. It means dark bands are 'A' or anisotropic bands. Whereas, the word 'Light' starts with alphabets 'L' and 'I', it means light bands are 'I' or isotropic bands.

10. (C) Striated muscles are also referred to as skeletal muscles because they are attached to bones. Their movements are controlled by our will, which is why they are known as voluntary muscles. Striated muscles can be found in the body wall, arms, legs, thigh, face, neck, and other areas. These muscles account for roughly half of our body weight. A striated muscle is made up of unbranched, long, narrow fibres with blunt ends. Myofibrils in the cytoplasm exhibit alternating light and dark bands, known as striations. Each muscle fibre contains numerous nuclei. On the other hand, the heart has involuntary and striated muscles. The intestine has non-striated and involuntary muscles. The upper arm has skeletal muscle fibres, fusiform in shape.

11. (B) During muscle contraction, the laterally projecting heads (cross-bridges) of the thick myosin myofilaments make contact with and rotate on the thin actin myofilaments. This pulls the thin myofilaments into the sarcomere's centre, past the thick myofilaments. The 'Z' lines come closer together, and the sarcomere becomes shorter. The 'A' band's length remains constant. Myofilaments (both actin and myosin) remain constant in length. The free ends of actin myofilaments move closer to the sarcomere's centre, bringing 'Z' lines closer together. 'I' bands become shorter, and the 'H' zone becomes narrower. A similar action in all sarcomeres results in the shortening of the entire myofibril and

thus, of the entire fibre and muscle, resulting in contraction.

12. (D) Sarcomere gives the striated appearance to skeletal and cardiac muscles and was firstly explained by Van Leeuwenhoek. A sarcomere is the portion of myofibril, located between two successive Z lines, and the I-band region surrounds the area of the Z line. After the I-band region, there is an A-band region, which contains the entire length of the thick filament. There is an area of H-zone within the A-band that is pale in colour, and the H-band contains no actin. Inside the H-band is another thin line called the M-line, which is formed by cross-connecting cytoskeleton components. Sarcomeres are fibrous proteins that act as filaments to help muscles move during contraction and relaxation.



13. (B) Skeletal muscles are another name for striated muscles. Sarcomeres are the functional units of the contractile system in striated muscles. Sarcomeres are composed of thin actin filaments and thick myosin filaments. These thin and thick filaments give the striated muscles light and dark bands. When these contractile proteins slide over each other, they cause contraction of muscles.

14. (C) Myosin is the contractile protein of the muscles. It is found within the myofibrils, which are a specific type of fibres that runs in parallel columns along the length of striated muscle fibres.

#### Related Theory

- Each thick myosin filament is a polymerised protein. One thick filament is made up of many monomeric proteins called meromyosins. Each meromyosin has two important parts: a globular head with a short arm and a tail, known as the heavy meromyosin (HMM) and the light meromyosin (LMM).

15. (D) Muscle is a fibrous tissue bundle in the body that has the ability to contract, causing movement or maintaining the position of body parts. Flexor muscle bends one part of a limb on another at a joint, e.g., biceps. It brings the fore arm towards the upper

arm. Flexor muscles work antagonistically with extensors. On the other hand, abductor (elevator) is a type of muscle whose function is to move a limb away from the body, e.g., deltoids of shoulder.

16. (C) 11<sup>th</sup> and 12<sup>th</sup> pairs of ribs are not connected ventrally with sternum. Thus, they are called floating ribs. Acromion is a flat expanded process of spine of scapula. The lateral end of clavicle articulates with acromion process. Scapula is a flat triangular bone in the dorsal part of thorax, located between 2<sup>nd</sup> and 7<sup>th</sup> rib. Glenoid cavity of scapula articulates with head of the humerus bone to form the shoulder joint.

17. (C) Vertebrosternal or true ribs are first seven pairs (1<sup>st</sup> to 7<sup>th</sup> pairs) of ribs attached dorsally to thoracic vertebrae and ventrally to the sternum. Vertebrochondral or false ribs (8<sup>th</sup>, 9<sup>th</sup> and 10<sup>th</sup> pairs) are attached dorsally to thoracic vertebrae and ventrally attached to 7<sup>th</sup> rib with hyaline cartilage (not directly to sternum). Vertebral or floating ribs (11<sup>th</sup> and 12<sup>th</sup>) are attached to vertebrae dorsally, and are not attached ventrally.

### Related Theory

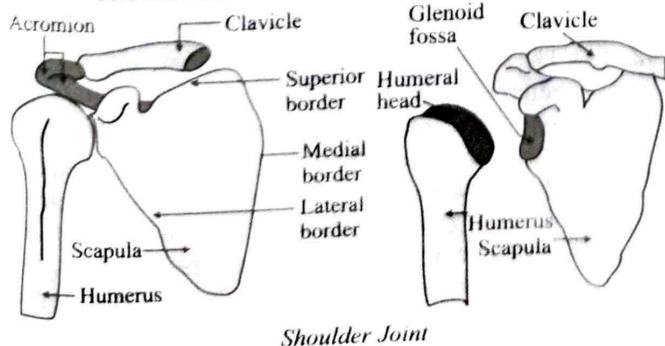
There are total 12 pairs of ribs. Each rib is a thin flat bone that connects to the vertebral column dorsally and ventrally to the sternum. The rib cage is made up of the thoracic vertebrae, ribs, and sternum.

18. (A) In the rib cage, there are total 12 pairs of ribs. Out of them, first 7 pairs are called true ribs, as they are attached to sternum ventrally and with vertebral column dorsally. The next 3 pairs (8<sup>th</sup>, 9<sup>th</sup>, and 10<sup>th</sup>) are called false ribs, as they are attached to 7<sup>th</sup> pair of ribs, instead of the sternum. The 11<sup>th</sup> and 12<sup>th</sup> pair are attached to vertebral column dorsally, but remain floating in the thoracic cavity and hence, known as floating ribs.

### Caution

Students usually get confused with dorsal and ventral position. In ventral, 'v' represent downward facing arrow, i.e., towards stomach and in humans, stomach is in the front of the body. Dorsal is the exact opposite, i.e., towards back of the body.

19. (D) The shoulder joint is formed by the articulation of the head of the humerus with the glenoid cavity (or fossa) of the scapula. This gives rise to the alternate name for the shoulder joint – the glenohumeral joint. The acromion is a bony process on the scapula.



### Related Theory

The humerus is held in place within the glenoid cavity by means of the long head of the biceps tendon. The rotator cuff also reinforces this joint more specifically with the supraspinatus tendon to hold the head of the humerus in the glenoid cavity.

20. (C) Production of body heat is the function of muscles. The contraction of muscles produce heat, which keeps the body warm. Erythropoiesis (production of erythrocytes) occurs in bone marrow. Bone is formed of various minerals, like calcium, phosphorus, sodium, etc., which dissolve from bones at the time of need. The primary function of skeletal system is the locomotion of the body.

### Caution

Students usually mix the terms movement and locomotion. They need to understand the difference between these two terms. Movement is the temporary or permanent displacement of a body or its parts from its original position, while locomotion, on the other hand, is the displacement of the entire body from one place to another. However, both movement and locomotion involve the coordinated activities of muscular, skeletal and neural system.

21. (B) Clavicle, scapula and glenoid cavity together forms the pectoral girdle of appendicular skeleton. Pelvic girdle is made of two coxal bones, each of which includes pubis, ilium and ischium.

### Related Theory

The hip joint is a ball-and-socket joint between the pelvis and femur, and the pelvis is a large bone structure located in the lower part of the body, which connects the spinal column and legs.

### Mnemonics

Our ears, too, have bones!! Tiny, very small, but crucial. Learn this simple trick for remembering the names of the ear bones.

Mailing Includes Stamps

Mailing – Malleus

Includes – Incus

Stamps – Stapes

22. (A) In humans, 11<sup>th</sup> and 12<sup>th</sup> pairs of ribs is known as floating ribs, as because they are attached only to the vertebrae and not to the sternum or cartilage of the sternum. A total of 20 amino acids are found in proteins. There are two types of diabetes: Type I and type II. There are total 7 cervical vertebrae in humans.

### Related Theory

Type I diabetes is an autoimmune reaction that attacks cells in your pancreas that produce insulin and is caused by inherited genetics or environmental elements. Type II diabetes happens when your body becomes resistant to insulin and is associated with genetics and lifestyle choice.

23. (B) Acromion process is found in the pectoral girdle of mammals. Pectoral girdle consists of scapula and clavicle. The acromion process is a small projection of the scapula that extends anteriorly from the spine of the scapula, and serves as the point of attachment for the deltoid muscle, which is the major muscle that allows us to lift or abduct our arms.

24. (B) The epiphyseal plate is the area of growth in a long bone. It is a layer of hyaline cartilage, where ossification occurs in immature bones responsible for the longitudinal growth of the long bones in birds and mammals.

### Related Theory

→ Hyaline cartilage is the glass-like, translucent cartilage found on many joint surfaces. It is also most commonly found in the ribs, nose, larynx, and trachea.

### Caution

→ Students must know that elastic cartilage is similar to hyaline cartilage except that the matrix also contains a dense network of branching and anastomosing elastic fibres. Hyaline cartilage is found in the ribs, nose, larynx, trachea, while elastic cartilage is found in the external ear, epiglottis and larynx.

25. (C) A ligament is the fibrous connective tissue that connects bones to other bones. If the ligaments are cut or broken, the bone will become unfixed.

### Related Theory

→ Tendons are dense fibrous tissues that bind the muscles to the bones. They are responsible for the movement by transmitting the contraction force produced by the muscles to the bone they hold.

### Caution

→ Students should remember that ligaments allow the movement but up to a limit.

26. (C) Pterygoid or pterygoid plate is a process that extends from sphenoid bone of skull to form a plate like structure. Each pterygoid process projects inferiorly from the junction of the body and greater wing of the sphenoid bone and bifurcates into a medial pterygoid plate and a lateral pterygoid plate.

27. (C) Sternum is connected to ribs by hyaline cartilage (giving a shiny glass-like appearance and flexibility and support at the joints). The sternum is also known as the breast bone. It is a narrow, elongated, and flattened structure found beneath the skin in the centre of the front of the chest. There are a total of twelve pairs of ribs. Both males and females have the same number. Each pair articulates with a different thoracic vertebra on the posterior side of the body and with the sternum on the anterior side. Ten of the twelve ribs connect to hyaline cartilage strips on the body's anterior side. The cartilage strips are known as costal cartilage, and they connect to the sternum on the other end.

28. (B) A man's hind limb has a total of 30 bones. One of a man's hind limbs is made up of 1 femur, 1 fibula, 1 tibia, 1 patella, 7 tarsals, 5 meta-tarsals, and 14 phalanges.

### Related Theory

→ Femur is the longest and strongest bone of the body.

### Mnemonics

→ Bones of hind limb can be learned as:

*The Female Priest Pluck Flowers with Tools and Machines*

<i>The</i>	– <i>Tibia</i>
<i>Female</i>	– <i>Fibula</i>
<i>Priest</i>	– <i>Patella</i>
<i>Pluck</i>	– <i>Phalanges</i>
<i>Flowers</i>	– <i>Femur</i>
<i>Tools</i>	– <i>Tarsals</i>
<i>Machines</i>	– <i>Meta-tarsals</i>

29. (D) There are two pairs of floating ribs present in human body. There are usually 12 pairs of ribs. The 11<sup>th</sup> and 12<sup>th</sup> pairs of ribs are called floating ribs because these ribs do not attach to the sternum or to another rib.

### Related Theory

→ In human body, there are 12 pairs of ribs, which form the bony lateral walls of the thoracic cage. The first 7 pairs of ribs are called true ribs; 8<sup>th</sup>, 9<sup>th</sup> and 10<sup>th</sup> pairs are called false ribs. The last two pairs of ribs are called floating ribs, as their anterior ends are not attached either to the sternum or another rib. The floating ribs protect the kidneys.

30. (A) A pectoral girdle or shoulder girdle connects the upper limb bones to the axial skeleton. Each pectoral girdle is split into two halves. A scapula and clavicle makes up each half of the pectoral girdle. The glenoid cavity is a shallow, pyriform articular surface located on the scapula's lateral angle. It joins the humerus to form the shoulder joint. As a result, the glenoid cavity is a part of the pectoral girdle.

31. (B) Long bones are hard, dense bones found in the upper and lower extremities (arms and legs) that provide strength, structure, and mobility. A good example of a long bone is the femur (thigh bone). Haemopoiesis (the production of blood cells) occurs in the proximal epiphyses of long bones. Long bones provide support as well as erythrocyte and leucocyte synthesis due to the presence of red bone marrow.

32. (A) The cervical spine, comprised of 7 cervical vertebrae referred to as C<sub>1</sub> to C<sub>7</sub>, is divided into two major segments: the craniocervical junction (CCJ) and the subaxial spine. The CCJ includes the occiput and the two most cephalad cervical vertebrae, known as the atlas (C<sub>1</sub>) and the axis (C<sub>2</sub>). In mammals, these vertebrae are always constant. Since whale, rabbit, horse, and giraffe are all mammals; they all typically have seven vertebrae. So, the cervical vertebrae in humans will be exactly same, as in whale.

## Mnemonics

Are you having trouble remembering the names and numbers of the bones in the vertebral column? Simply repeat this simple phrase and memorise the names.

*Charlie Tucker Likes the School Center*

Charlie	-	Cervical vertebrae (7)
Tucker	-	Thoracic vertebrae (12)
Likes	-	Lumbar vertebrae (5)
School	-	Sacrum (1)
Center	-	Coccyx (1)

33. (D) Deltoid ridge is the roughly triangular area on the anterolateral (front-side) surface of the middle of the humerus. In the humerus bone, pectoral and deltoid ridges are important points of muscle attachment.

34. (A) Ball and socket joint is found in between humerus and pectoral girdle. Hinge joint is present in knees. Pivot joint is found in between atlas and axis and gliding joint is found in between the carpals. These joints are synovial joints that allows considerable movements.

35. (C) Fibrous joints do not allow any movement. This type of joint is shown by the flat skull bones. The cartilaginous joint is observed between the adjacent vertebrae in the vertebral column and it permits limited movements. Ball and socket joint is present between humerus and pectoral girdle and allows rotational movement. Hinge joint (knee joint) helps in locomotion. They are synovial joints characterised by the presence of a fluid filled synovial cavity between the articulating surfaces of the two bones.

36. (D) Cartilaginous joint are the joints between the two adjacent vertebrae in the vertebral column.

A ball and socket joint is a type of synovial joint in which the ball-shaped head of one bone fits into the cup-like socket of another bone. This type of joint is found between humerus and pectoral girdle.

The type of joint between the human skull bones is called fibrous joint.

Carpal-metacarpal joint of the thumb is the example of saddle joint.

37. (D) The scapula (shoulder blade) is a triangular flat pectoral girdle bone located on the dorsal side of the thorax.

Cranium is composed of flat bones that fuse end-to-end with the support of dense fibrous connective tissues. These cranial joints, known as fibrous joints, do not allow any movement.

The sternum, also known as the breast bone, is a flat bone located on the ventral midline of the thorax.

The joints in the vertebral column between adjacent vertebrae are examples of cartilaginous joints because they are joined with cartilage. These joints allow for only limited movement.

38. (A) Gliding joint is present between the carpals. Hinge joint is present between the humerus and ulna. Pivot joint is present between the atlas and axis. Saddle joint is present between the carpal and metacarpal of thumb.

39. (C) The atlas and axis form the atlanto-axial joint, which allows head rotation is a compound synovial joint. Fibrous joint do not allow movement and is present between the skull bones. Cartilaginous joint allows slight movement and present in pubis symphysis. Saddle joint is a synovial joint, present between carpals and metacarpals of thumb.

## Mnemonics

Trick to learn the different types of synovial joints and their locations are-

(1) *Bharat Sarkar Hindustan Petroleum*

*Bharat Sarkar – Ball and Socket joint*

*Hindustan Petroleum – present between Humerus and Pectoral girdle*

(2) *Hired Key*

*Hired – Hinge joint*

*Key – Knee joint*

(3) *Sandeep's Cars are Mustang & Thar*

*Sandeep's – Saddle joint*

*Cars are Mustang & Thar - present between Carpal and Metacarpal of Thumb*

(4) *Pihu Ate Apple*

*Pihu – Pivot joint*

*Ate Apple – present between Atlas and Axis*

(5) *Gliding Car*

*Gliding – Gliding joint*

*Car – present between the Carpal*

40. (A) Fibrous joints are connected by dense connective tissue consisting mainly of collagen. These joints are also called fixed or immovable joints because they do not move. Cartilaginous joints generally allow more movement than fibrous joints but less movement than synovial joints. A synovial joint (diarthrosis), is the freely movable type of joint having cavity filled with synovial fluid. Ball and socket joint is a type of synovial joint.

## Related Theory

Fibrous joints have no joint cavity and are connected via fibrous connective tissue. The skull bones are connected by fibrous joints called sutures. The skull bones of a foetus are unfused so that they can move over each other slightly to compress skull size during birth. After birth, the bones slowly begin to fuse to become fixed, making the skull bones immovable in order to protect the brain from impact. Syndesmosis of long bones and gomphoses of teeth are also types of fibrous joints.

41. (D) Gliding joint is present between the carpals.

42. (C) Joint between atlas and axis is a pivot joint, while knee joint is a hinge joint. Both pivot and Knee joint are type of synovial joint. Synovial joint is

characterised by the presence of synovial fluid cavity between the articulating surface. Skull bone have fibrous joints.

43. (A) Immovable/fixed/fibrous joint are present between the skull bones. So, parietal bone and the temporal bone of the skull are joined by fibrous joint. First cervical vertebra, *i.e.*, atlas, joins the second cervical vertebra, *i.e.*, axis to form pivot joint. The last two pairs of ribs are called floating ribs because their anterior ends are not attached to either the sternum or the cartilage of anterior rib. 8<sup>th</sup>, 9<sup>th</sup> and 10<sup>th</sup> ribs are called false ribs, as they are connected to the costal cartilages of the ribs just above them, not to the sternum directly. Glenoid cavity is a depression to which humerus articulates.



### Mnemonics

Cranial bones can be memorised as:

**Eric's Fried and Spicy Pasta Tempted Olivia and Chloe**

Eric's	-	<b>Ethmoid</b>
Fried	-	<b>Frontal</b>
Spicy	-	<b>Sphenoid</b>
Pasta	-	<b>Parietal</b>
Tempted	-	<b>Temporal</b>
Olivia	-	<b>Occipital</b>
Chloe	-	<b>Cranial</b>

44. (B) Elbow joint is an example of hinge joint. Hinge joint is a type of synovial joint, which allows the movement in one plane.

45. (B) Gliding joints occur between the carpal bones, between the tarsal bones and those between the articular processes (zygapophyses) of the successive vertebrae.

46. (C) The cartilaginous joint is present between the ribs and the sternum. These joints have a very limited range of motion.

Angular joints are based on their movement, *i.e.*, these joints allow the angular movement. The angular movements are produced when the angle between the bones of a joint changes; they include flexion, extension, hyperextension, abduction, adduction, and circumduction.

The bones of fibrous joints are joined by fibrous tissue, *e.g.*, sutures in the skull. Fibrous joints are completely immobile.

The gliding joint is a synovial joint formed between two bones that meet on flat articular surfaces to allow sliding or gliding motion. Wrist joints, joints between two vertebrae, ankle joints, acromioclavicular joints, and other gliding joints are some examples.

47. (C) A pivotal joint is one that exists between the atlas and the axis. The pivot joint is a vertebrate anatomy joint that only allows for rotational movement. The joint between the atlas and the axis, directly below

the skull, is an example of this, as it allows the head to rotate from side to side. The pivot joint aids in neck movement. They spin on each other. The atlas is the first cervix bone beneath the head, and the axis is the second.



### Related Theory

→ The *atlas bone* is named after the Greek god, *Atlas*, who supported the globe on his shoulders. The *axis* contains the odontoid system, which revolves around the *atlas*. Capsular, atlantoaxial anterior and posterior, and transverse ligaments are the ligaments that allow the pivot joint to stabilise and strengthen.

48. (B) Osteoporosis is an age-related disorder that primarily affects women after menopause. Calcium plays an important role in this disease. Reduced calcium levels cause a decrease in bone density and, as a result, bone mass. Due to this, the bones become porous, and the disease is known as osteoporosis. Low bone mass causes weak and brittle bones, making them more prone to fractures. Low estrogen levels are a common cause of this disease. This hormone is necessary for the formation of bone-forming cells, known as osteoblasts.



### Related Theory

→ Estrogen is a female hormone produced by the ovaries. After menopause, estrogen levels drop, affecting bone density and leading to fractures, pain, and stiffness.

49. (D) Arthritis is a disorder associated with muscular and skeletal system. In this disease, inflammation of joints takes place. It is not an inherited disease. On the other hand, Tetany is characterised by muscle spasms (wild contractions) caused by low  $\text{Ca}^{++}$  levels in the body fluid. Myasthenia gravis is an autoimmune disorder that affects the neuromuscular junction, causing fatigue, weakness, and paralysis of skeletal muscle. Muscular dystrophy is a progressive skeletal muscle degeneration caused primarily by a genetic disorder.

50. (A) Muscular dystrophy is an X-linked recessive, inherited muscular disorder, which occurs due to the absence of dystrophin protein to keep the muscles intact. This disorder can be characterised by the progressive degeneration of skeletal muscles.

51. (C) Osteoporosis is caused by a decreased level of oestrogen and a decreased level of calcium ions, especially in post-menopausal women.



### Related Theory

→ Oestrogen deficiency accelerates bone loss in post-menopausal women but also in men. Oestrogen deficiency can lead to excessive bone resorption accompanied by inadequate bone formation. Oestrogen deficiency increases the number of osteoclasts and decreases the number of osteoblasts resulting in overall bone resorption. The oestrogen-replete state may

*enhance osteoclast apoptosis via increased production of transforming growth factor (TGF)-beta.*

52. (B) Inflammation of joints due to accumulation of uric acid crystals is gout. Fibrous joints are formed by the flat skull bones, which fuse end-to-end with the help of dense fibrous connective tissue in the form of sutures to form cranium. The vertebral column is formed by 26 serially arranged units called vertebral column. Less secretion of progesterone causes abortion, as it is a pregnancy hormone. While, decreased level of estrogen causes osteoporosis in old people.

53. (B) Osteoporosis is a condition where the bones become fragile and brittle due to loss of bone tissue. It is

caused due to deficiency of calcium or vitamin D, or hormonal changes. Muscular dystrophy is a genetic disorder, which is characterised by progressive skeletal muscle weakness, defects in muscle proteins and the death of muscle cells and tissue. Myasthenia gravis is an auto-immune neuromuscular disease in which muscle becomes weak, which is caused by circulating antibodies that block acetylcholine receptors at the postsynaptic neuromuscular junction inhibiting the excitatory effects of the acetylcholine. Gout is inflammation of joints, which is caused by elevated levels of uric acid in the blood, which crystallises and the crystals are deposited in joints, tendons and surrounding tissues.

