CHAPTER › 20

Locomotion and Movement

NEET KEY NOTES

- Movement is a key characteristic shown by living organisms with few exceptions and may be defined as a change in posture or position.
- Voluntary movements result in **locomotion**. Walking, running, climbing, flying, swimming are some forms of locomotory movements. Cilia in *Paramecium* and tentacles in *Hydra* help in locomotion along with their respective functions.
- All locomotions are movements, but all movements are not locomotions.

Types of Movement

- Various movements exhibited by different cells and organs of human body are tabulated below

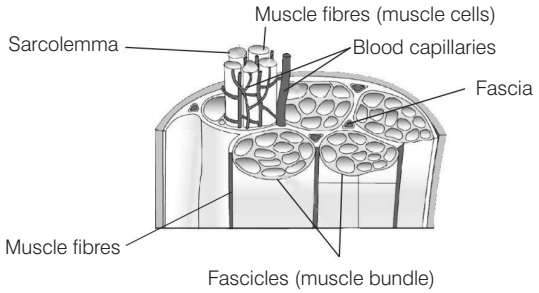
Types of movement	Characteristics	Examples
Amoeboid	Effected by pseudopodia formed by streaming of the protoplasm.	Macrophages and leucocytes
Ciliary	Exhibited by organs/ structures lined by ciliated epithelium.	Internal tubular organs lined by ciliated epithelium, e.g. respiratory tract of human, Fallopian tubes of females.
Muscular	Effected by the contractile property of muscles.	Movement of jaws, limbs, tongue, etc.
Flagellar	Effected by the beating of flagella.	Swimming of spermatozoa.

Muscular System

- Muscles are specialised tissues of mesodermal origin that may show both **voluntary** and **involuntary movements**. They possess properties such as excitability, contractility, extensibility and elasticity.
- Based on their location, muscles are of three types, i.e.
  - **Skeletal muscles** are the striated, multinucleate, voluntary muscles. These are attached to the skeleton and hence are named skeletal muscles. They are involved in locomotory actions and changes in body posture.
  - **Visceral/Non-striated muscles** are also called as **smooth muscles**. These are uninucleate, non-striated, involuntary muscles. These are located in the inner walls of hollow visceral organs of the body like alimentary canal, reproductive tract, etc. These help in the transportation of food through digestive tract and gametes through genital tract.
  - **Cardiac muscles** are the muscles of heart. These resemble striated muscles but are uninucleate. These are involuntary in nature and are under indirect control of the nervous system.

Structure of Skeletal Muscle

- The skeletal muscle consists of multiple muscle bundles or **fascicles**, held together by **fascia**. Each muscle bundle contains a number of **muscle fibres**, surrounded by sarcolemma containing **sarcoplasm** (cytoplasm of muscle fibre).
- The sarcoplasm contains myoglobin (red colour pigment), sarcosomes (mitochondria of muscle fibre) and sarcoplasmic reticulum (endoplasmic reticulum of muscle fibres that is the storehouse of calcium ions).
- Each muscle fibre contains many thin and rod-like parallely arranged filaments in its sarcoplasm called **myofilaments** or **myofibrils**.



Diagrammatic cross-sectional view of a muscle

- Each myofibril has alternating dark (A or Anisotropic) and light (I or Isotropic) bands. At the centre of A-band, H-zone (or Henson's zone) is present which is a comparatively less dark zone. Further, at the centre of H-zone, M-line is present.
- In case of I-band, a dark membrane called Z-line is present at its centre.
- The part of myofibril between two successive Z-lines is **sarcomere** (functional unit of myofibril). The striated appearance of skeletal muscles is due to the distribution pattern of two important proteins called **actin** and **myosin**.
- These proteins are arranged as rod-like filaments, parallel to each other and also to the longitudinal axis of the myofibrils. Actin filaments are thinner compared to myosin filaments hence called thin and thick filaments, respectively.

Structure of Contractile Proteins

- Each actin (thin) filament is made of two '**F**' (filamentous) **actins** helically wound around each other. Each of these 'F' actins is a polymer of monomeric '**G**' (globular) **actins**. Two filaments of another protein called **tropomyosin** also run close to the F actins throughout its length. A complex protein, **troponin**, is distributed at regular intervals on the tropomyosin. At resting phase, a troponin subunit masks the active binding sites for myosin on the actin filaments.
- Each myosin (thick) filament is also a polymerised protein containing many monomeric proteins called **meromyosin.** Each meromyosin contains a globular head with a short arm (called the Heavy Meromyosin, i.e. HMM) and a tail (called the Light Meromyosin, i.e. LMM). The HMM component projects outward from the surface of polymerised myosin filament and forms cross arm. The globular head is an active ATPase enzyme and has binding sites for ATP and active sites for actin.

Mechanism of Muscle Contraction

- It is best explained by the sliding filament theory which states that contraction of a muscle fibre takes place by the sliding of the thin filaments over the thick filaments.

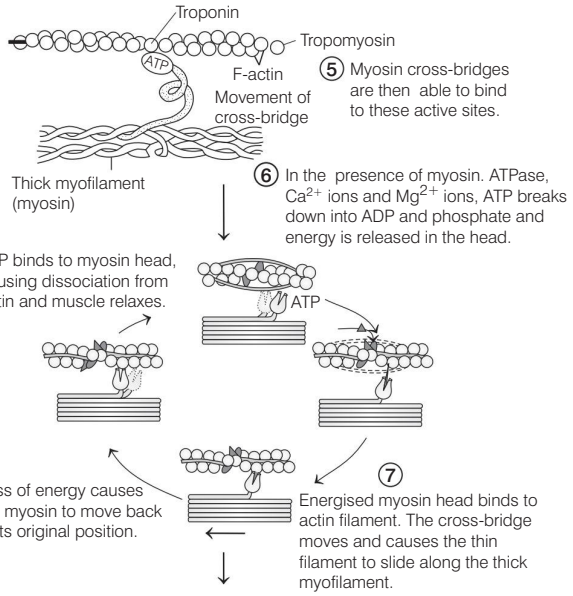
The electrical and biochemical events in muscle contraction are as follows

① Nerve impulse causes the release of acetylcholine from synaptic vesicles into the synaptic cleft.

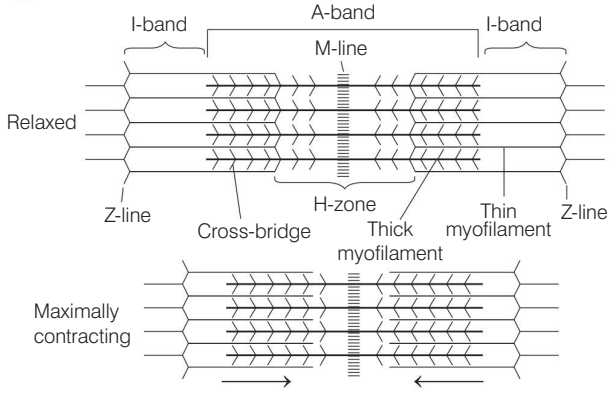
② Acetylcholine present in the synaptic cleft binds to the receptor sites of motor end plate and causes its depolarisation which creates an action potential.

③ Action potential reaches sarcoplasmic reticulum of muscle fibre and causes the release of calcium ions into sarcoplasm.

④ Calcium ions bind to troponin and change its shape which in turn changes the shape of tropomyosin and expose the active sites on the F-actin.



⑩ As a result, the sarcomere shortens as shown below



Contraction in a sarcomere of muscles

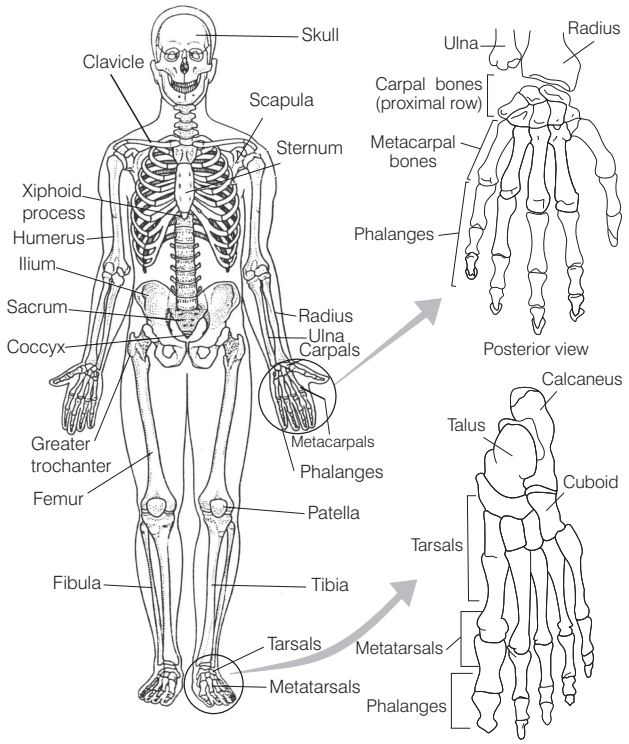
- Thic process continues till Ca^{2+} are pumped back to the sarcoplasmic cisternae, masking the actin filaments. This causes relaxation of the muscle.
- On the basis of amount of **myoglobin** in muscle fibres, these are categorised into **red** and **white muscle fibres**. Red fibres contain more myoglobin and mitochondria as compared to

white fibres. Red muscle fibres are aerobic muscles and white muscle fibres are anaerobic muscles.

- **Oxygen debt** is the extra oxygen required by the body muscles during relaxation or recovery period over the strenuous state.
- **Rigor mortis** is the state of body stiffening after death which occurs due to the permanent irreversible contraction between actin and myosin, which in turn occurs due to exhaustion of ATP from blood.

Skeleton System

The human skeleton system consists of **axial** and **appendicular skeletons**. The total number of bones in an adult human is 206. The axial skeleton of human consists of **80 bones** and the appendicular skeleton of human consists of **126 bones**.



Structure of human skeleton

Important Bones in Human Skeleton

Part of body	Part of endoskeleton	Region	Name of bone (Numbers)
I. **Axial skeleton** (Total bones 80)			
Head	Skull	Cranium	• Occipital (1) • Parietal (2) • Frontal (1) • Temporal (2) • Sphenoid (1) • Ethmoid (1)
		Facial region	• Nasal (2) • Vomer (1) • Turbinal (2) • Lacrimal (2) • Zygomatic (2) • Palatine (2) • Maxilla (2) • Mandible (1)
		Ear ossicles	• Malleus (2) • Incus (2) • Stapes (2)
		Hyoid	• Hyoid body (1)
Backbone	Vertebral column	Neck	• Cervical vertebrae (7)
		Thorax	• Thoracic vertebrae (12)
		Waist	• Lumbar vertebrae (5)
		Sacrum	• Sacral vertebrae or Sacrum (5 in child) (1)
		Tail	• Caudal vertebrae or Coccyx (4 in child) (1)
Thorax	Sternum		• Sternum (1)
	Ribs		• True ribs (14) • False ribs (6) • Floating ribs (4)

- The skull region articulates with the superior region of the vertebral column with the help of two occipital condyles (dicondylic skull).
- First vertebra is the atlas and it articulates with the occipital condyles.

Part of body			
II. **Appendicular Skeleton** (Total bones 128)			
Thorax	Pectoral girdle	Shoulder	• Scapula (2) • Clavicle (2)
Hip	Pelvic girdle		• Innominate (2)
Forelimbs		Upper arm	• Humerus (2)
		Forearm	• Radius (2) • Ulna (2)
		Wrist	• Carpals (16)
		Palm	• Metacarpals (10)
		Fingers	• Phalanges (28)
Hindlimbs		Thigh	• Femur (2)
		Shank	• Tibia (2) • Fibula (2)
		Knee	• Patella (2)
		Ankle	• Tarsals (14)
		Sole	• Metatarsals (10)
		Fingers	• Phalanges (28)

- Acromion process of scapula articulates with clavicle. Glenoid cavity below acromion articulates with the head of humerus to form the shoulder joint.

- At the point of fusion of ilium, ischium and pubis, a cavity called **acetabulum** is present with which the thigh bone articulates.

Joints

The points of contact between bones or between bones and cartilages are called **joints**. Bones articulate with one another at the joint. Joints are of three types as follows

- **Fibrous joints**, these do not allow any movement. These are found in between flat bones of skull which fuse end-to-end with the help of dense fibrous connective tissues in the form of sutures, to form cranium.
- **Cartilaginous joints**, these allow limited movements. In these joints, the bones involved are joined through cartilage, e.g. in between adjacent vertebrae in the vertebral column.
- **Synovial joints**, these are characterised by the presence of synovial cavity between the articulating surface of two bones. Such an arrangement allows considerable movement. Some examples are
  - **Ball and socket joint** (between humerus and pectoral girdle).
  - **Hinge joint** (knee joint)
  - **Pivot joint** (between atlas and axis)
  - **Gliding joint** (between the carpals)
  - **Saddle joint** (between carpals and metacarpals of thumb).

Disorderds of Muscular and Skeletal System

Some common disorders of muscular and skeletal system are as follows

- **Myasthenia gravis** Autoimmune disorder affecting the neuromuscular junction and leading to fatigue, weakening and paralysis of the skeletal muscles.
- **Muscular dystrophy** Progressive degeneration of the skeletal muscles mostly due to genetic disorder.
- **Tetany** Rapid spasms (wild contractions) in the muscle due to low Ca^{2+} ions in body fluid.
- **Arthritis** Inflammation of joints.
  - **Osteoarthritis** caused due to the wearing away of the cartilage which covers the bones in the joints.
  - **Rheumatoid arthritis** caused due to the inflammation of synovial membrane and can affect middle aged and older people.
- **Osteoporosis** Age related disorder characterised by decreased bone mass and increased chances of fractures.
- **Gout** Inflammation of joints due to the accumulation of uric acid crystals.

Mastering NCERT

MULTIPLE CHOICE QUESTIONS

TOPIC 1 ~ *Types of Movement, Muscles and Mechanism of Muscle Contraction*

1 Streaming of the cytoplasm/cyclosis is seen in
(a) *Amoeba* (b) earthworm
(c) *Nereis* (d) leech

2 Amoeboid movements occur due to streaming of protoplasm in
(a) macrophages and leucocytes
(b) spermatozoa, *Amoeba* and erythrocytes
(c) erythrocytes and leucocytes
(d) spermatozoa and macrophages

3 All locomotions are movements
(a) and all movements are locomotions
(b) but all movements are not locomotions
(c) which result in no change of place or location
(d) Either (a) or (c)

4 Ciliary movements within human body can be observed in
(a) trachea (b) Fallopian tube
(c) Both (a) and (b) (d) None of these

5 Movement of our limbs, jaws, tongue, etc., requires
(a) ciliary movement
(b) amoeboid movement
(c) muscular movement
(d) flagellar movement

6 Locomotion is effected due to
(a) contractile property of muscles
(b) movement of skeletal elements
(c) motor signal through neural system
(d) All of the above

7 In which of the following processes, flagellar movements are involved?
(a) Swimming of spermatozoa
(b) Maintenance of water current in spongocoel of sponges
(c) Locomotion in *Euglena*
(d) All of the above

8 Locomotory actions within human body are carried out using
(a) unstriped muscles (b) striated muscles
(c) involuntary muscles (d) visceral muscles

9 Visceral muscles are likely to be found in
(a) brain and spinal cord (b) digestive tract
(c) biceps and triceps (d) All of these

10 Visceral muscles are also called
(a) smooth muscles (b) non-striated muscles
(c) involuntary muscles (d) All of these

11 Cardiac muscles are
(a) smooth and voluntary (b) smooth and involuntary
(c) striated and involuntary (d) striated and voluntary

12 The muscle bundles, fascicles are held together by the collagenous connective tissue called
(a) intercalated disc (b) myofibril
(c) fascia (d) All of these

13 The sarcolemma lines a
(a) muscle fibre (b) fascia
(c) fascicle (d) All of these

14 The storehouse of calcium ions in the muscle fibre is
(a) smooth endoplasmic reticulum
(b) Golgi body
(c) sarcoplasmic reticulum
(d) lysosomes

15 What is/are the function(s) of calcium? ***JIPMER 2018***
(a) Blood clotting (b) Muscular contraction
(c) Nerve conduction (d) All of these

16 Myofilaments or Myofibrils are
(a) obliquely arranged filaments of muscle fibre
(b) parallelly arranged filaments of muscle fibre
(c) horizontally arranged filaments of muscle fibre
(d) radially arranged filaments of muscle fibre

17 Myofibrils appear striated due to the presence of
(a) actin in lighter region and myosin in darker region
(b) actin throughout the length of myofibril
(c) myosin in lighter region and actin in darker region
(d) myosin throughout the length of myofibril

18 The light and dark regions of myofibril are called
(a) I–band and A–band, respectively
(b) L–band and D–band, respectively
(c) A–band and I–band, respectively
(d) A–band and M–band, respectively

19 Actin and myosin filaments of muscles are also called
(a) thick and thin filaments, respectively
(b) thin and thick filaments, respectively
(c) black and white filaments, respectively
(d) white and black filaments, respectively

20 Choose the incorrect pair.
(a) Globular head of meromyosin – Active ATPase enzyme
(b) Thin fibrous membrane holding – M-line thick filaments in A-band
(c) Dark bands – Isotropic band
(d) None of the above

21 In the centre of each I-band, there is an elastic fibre called
(a) I-line (b) Z-line
(c) A-line (d) H-zone

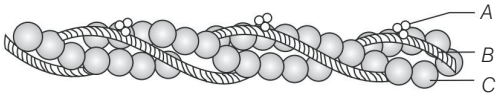
22 A sarcomere in the myofibrils of muscle is found in between two successive
(a) M-lines (b) Z-lines
(c) H-zones (d) A-bands

23 Sarcomere is a
(a) functional unit of contraction
(b) portion of myofibril present in between two M-lines
(c) complete bundle of muscles
(d) portion of myofibril present in between two A-bands

24 The H-zone in the skeletal muscle fibre is due to ***NEET 2013***
(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

25 F-actin is a polymer of
(a) troponin (b) globular actin
(c) meromyosin (d) tropomyosin

26 Identify *A, B* and *C* in the given diagram.



(a) A–Troponin, B–Tropomyosin, C– F-actin
(b) A–Thick filament, B–Troponin, C–Tropomyosin
(c) A–Myosin filament, B–Troponin, C–Tropomyosin
(d) A–Meromyosin, B–Troponin, C–Tropomyosin

27 Troponin bearing filament protein in thin filament is
(a) actin
(b) meromyosin
(c) tropomyosin
(d) myosin

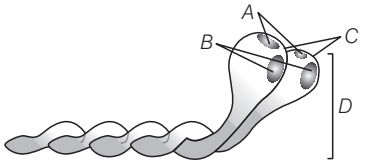
28 The active binding sites for myosin on actin filament are masked by
(a) Ca^{2+} ions (b) troponin
(c) F-actin (d) tropomyosin

29 Which one is incorrectly matched?
(a) Heavy meromyosin — Globular head
(b) Smooth muscle — Involuntary muscle
(c) Red muscle — Myoglobin
(d) Troponin — Fibrous protein

30 Cross arms of the myosin monomer consist of
(a) outward projection of G-actin filament
(b) outward projection of the head region of meromyosin
(c) outward projection of the tail region of meromyosin
(d) Both (b) and (c)

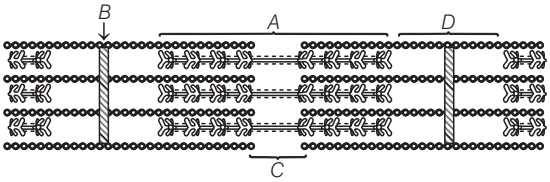
31 Actin binding sites are located on
(a) troponin (b) tropomyosin
(c) meromyosin (d) Both (a) and (c)

32 Identify *A, B, C* and *D* in the given diagram and choose the correct option.



(a) A–Actin binding site, B–ATP binding site, C–Head, D–Cross arm
(b) A–Actin binding site, B–ATP binding site, C–Head, D–Side arm
(c) A–Actin binding site, B–ATP binding site, C–Head, D–Long arm
(d) A–Actin binding site, B–ATP binding site, C–Head, D–Short arm

33 Given below is the figure of a sarcomere. Identify the parts labelled as *A* to *D* and select the correct option.



	A	B	C	D
(a)	A-band	Z-line	H-zone	I-band
(b)	A-band	H-line	Z-zone	I-band
(c)	I-band	H-line	Z-zone	A-band
(d)	I-band	Z-line	H-zone	A-band

34 Mechanism of muscle contraction is best explained by
(a) physical filament theory
(b) chemical filament theory
(c) sliding filament theory
(d) jumping filament theory

35 Contraction of the muscles takes place by the sliding of
(a) thick filament over thin filament
(b) thin filament over thick filament
(c) thin filament over thin filament
(d) thick filament over thick filament

36 Skeletal muscle contraction is initiated by a signal sent by
(a) CNS
(b) PNS
(c) ANS
(d) Neutral transmitters

37 Motor unit is a
(a) neuron only
(b) muscle fibre only
(c) motor neuron with muscle fibre
(d) All of the above

38 Neuromuscular junction is a junction between
(a) two neurons and muscles
(b) sensory neurons and muscles
(c) motor neurons and sarcolemma of muscles
(d) sensory neurons and sarcolemma of muscles

39 Action potential in the sarcolemma of muscles is generated by
(a) neuroinhibitors (b) acetylcholine
(c) methylcholine (d) ethylcholine

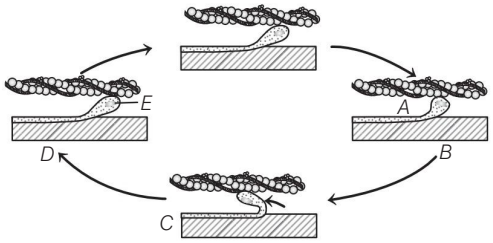
40 Action potential in sarcolemma of muscles causes the release of which ions from sarcoplasmic reticulum?
(a) Na^+ (b) Cl^-
(c) Ca^{2+} (d) HCO_3^-

41 Name the ion responsible for unmasking of active sites for myosin for cross-bridge activity during muscle contraction. ***NEET 2016***
(a) Calcium (b) Magnesium
(c) Sodium (d) Potassium

42 Upon stimulation of skeletal muscles, calcium is immediately made available for binding to troponin from
(a) blood
(b) lymph
(c) sarcoplasmic reticulum
(d) bone

43 Calcium is important in skeletal muscle contraction because it ***NEET 2018***
(a) detaches the myosin head from the actin filament
(b) activates the myosin ATPase by binding to it
(c) binds to troponin to remove the masking of active sites on actin for myosin
(d) prevents the formation of bonds between the myosin cross-bridges and the actin filament

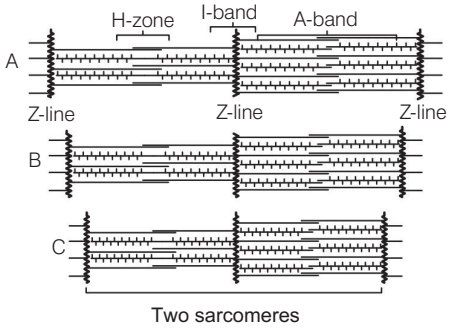
44 Identify *A* to *E* in the given diagram.



(a) A–Cross-bridge, B–Cross-bridge formation C–Breakage of cross-bridge, D–Sliding E–ATP
(b) A–Cross-bridge, B–Cross-bridge formation, C–Sliding/rotation, D–Breaking of cross-bridge, E–ATP
(c) A–Cross-bridge, B–Breaking of cross-bridge, C–Sliding/rotation, D–Cross-bridge formation, E–AMP
(d) A–Cross-bridge, B–Cross-bridge formation, C–Sliding/rotation, D–ADP, E–Breaking of cross-bridge

45 Which muscle band remains unchanged during the contraction and relaxation of the skeletal muscle?
(a) I (b) H (c) A (d) E

46 Identify the state of sarcomere in the diagram and choose the correct option accordingly.



(a) A–Contracting, B–Relaxed, C–Maximally contracted
(b) A–Relaxed, B–Contracting, C–Maximally contracted
(c) A–Maximally contracted, B–Contracting, C–Relaxed
(d) A–Relaxed, B–Maximally contracted, C–Contracting

47 Consider the following events
I. I-band shortens
II. A-band retains its length
III. H-zone shortens
IV. Sarcomere elongation
V. ATP formation from ADP and Pi.
Choose the option containing the events which do not occur during skeletal muscle contraction.
(a) Only I
(b) Only III
(c) IV and V
(d) Only II

48 For how long, contraction of the muscles continues in sliding filament theory?
(a) Till ATP binds to myosin head
(b) Till ADP binds to myosin head
(c) Till Ca^{2+} present in sarcoplasm
(d) Till polymerisation of myosin head is going on

49 Muscle contains a red coloured oxygen containing pigment called
(a) rhodopsin
(b) myoglobin
(c) haemocyanin
(d) Both (a) and (b)

50 Aerobic muscles and anaerobic muscles are called
(a) red fibres; white fibres, respectively
(b) white fibres; red fibres, respectively
(c) white fibres; yellow fibres, respectively
(d) red fibres; yellow fibres, respectively

TOPIC 2 ~ *Skeletal System*

51 Skeletal system consists of
(a) bones and cartilages
(b) bones and muscles
(c) only bones
(d) only cartilage

52 Hardness of the bones is due to
(a) hard matrix made up of calcium salts
(b) hard matrix made up of phosphates
(c) hard matrix made up of sodium salts
(d) hard matrix made up of chelates

53 Cartilage has pliable matrix due to the presence of
(a) chondroitin salts (b) osteoblast
(c) chondroblast (d) osteoclast

54 Which of the following is not a function of the skeletal system? ***CBSE-AIPMT 2015***
(a) Production of erythrocytes (b) Storage of minerals
(c) Production of body heat (d) Locomotion

55 A U-shaped bone present at the base of buccal cavity is
(a) ethmoid bone (b) malleus
(c) hyoid bone (d) lacrimal bone

56 Find out the correct order of number of bones in the human skull (i.e. cranial bone, facial bone, hyoid bone and middle ear bone, respectively).
(a) 14, 8, 1 and 3 (b) 6, 8, 14 and 1
(c) 14, 8, 3 and 1 (d) 8, 14, 1 and 6

57 Which of the following bones is a part of human skull?

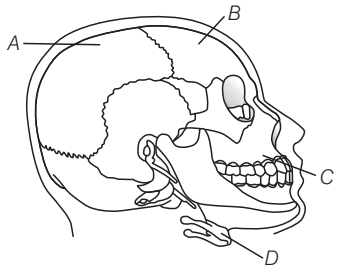
(a) Frontal bone–1 (b) Parietal bone–2
(c) Temporal bone–2 (d) All of these

58 Middle ear contains three tiny bones.

I. Maxillae II. Malleus
III. Incus IV. Stapes
V. Vomer

(a) I, II and III (b) II, III and IV
(c) III, IV and V (d) I, II and V

59 Identify *A, B, C* and *D* in the given diagram of humans skull, choose the correct option.

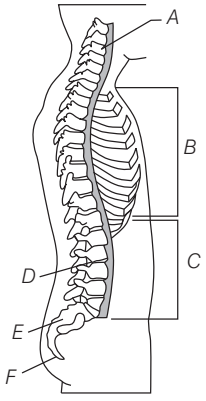


(a) A–Hyoid bone, B–Maxilla, C–Frontal bone, D–Parietal bone
(b) A–Hyoid bone, B–Maxilla, C–Parietal bone, D–Frontal bone
(c) A–Maxilla, B–Hyoid bone, C–Parietal bone, D–Frontal bone
(d) A–Parietal bone, B–Frontal bone, C–Maxilla, D–Hyoid bone

60 Our vertebral column is formed by the

(a) 26 serially arranged units called vertebrae
(b) 27 serially arranged units called vertebrae
(c) 33 serially arranged units called vertebrae
(d) 35 serially arranged units called vertebrae

61 Examine the figure of vertebral column (right lateral view) and identify *A*, *B*, *C*, *D*, *E* and *F*.



	A	B	C	D	E	F
(a)	Lumbar vertebrae	Thoracic vertebrae	Cervical vertebrae	Intervertebral disc	Sacrum	Coccyx
(b)	Cervical vertebrae	Thoracic vertebrae	Lumbar vertebrae	Intervertebral disc	Sacrum	Coccyx
(c)	Thoracic vertebrae	Cervical vertebrae	Intervertebral disc	Lumbar vertebrae	Coccyx	Sacrum
(d)	Cervical vertebrae	Thoracic vertebrae	Lumbar vertebrae	Intervertebral disc	Coccyx	Sacrum

62 The human vertebral column is ..... .

(a) horizontally placed (b) dorsally placed
(c) ventrally placed (d) longitudinally placed

63 Neural canal is

(a) the solid portion of vertebrae through which the spinal cord passes
(b) the hollow portion of vertebrae through which the spinal cord passes
(c) Both (a) and (b)
(d) None of the above

64 Atlas is ***JIPMER 2019***

(a) 1st cervical vertebra
(b) 2nd cervical vertebra
(c) 1st thoracic vertebra
(d) 2nd lumbar vertebra

65 The number of cervical vertebrae in almost all mammals is

(a) four (b) five
(c) six (d) seven

66 The vertebral column in humans

(a) protects the spinal cord
(b) supports the head
(c) provides surface as an attachment for ribs and musculature of back
(d) All of the above

67 Fused vertebrae in human are

I. Sacral II. Coccygeal
III. Thoracic IV. Cervical
V. Lumbar

(a) I and II (b) III and IV
(c) IV and V (d) II and V

68 Flat bone on the ventral midline of thorax to which ribs are attached is

(a) coccyx (b) sternum
(c) sacrum (d) ribs

69 How many pairs of ribs are present in human skeleton?

(a) 10 pairs (b) 12 pairs
(c) 9 pairs (d) 7 pairs

70 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.

NEET 2017

(a)	$X = 12, Y = 7$	True ribs are attached dorsally to vertebral column and ventrally to the sternum.
(b)	$X = 12, Y = 5$	True ribs are attached dorsally to vertebral column and sternum on the two ends.
(c)	$X = 24, Y = 7$	True ribs are dorsally attached to vertebral column, but are free on ventral side.
(d)	$X = 24, Y = 12$	True ribs are dorsally attached to vertebral column, but are free on ventral side.

71 False ribs are ventrally attached to
(a) sternum through hyaline cartilage
(b) seventh rib through hyaline cartilage
(c) seventh rib through fibrous cartilage
(d) sternum through fibrous cartilage

72 The rib cage is formed by
(a) thoracic vertebrae (b) ribs
(c) sternum (d) All of these

73 Bones of the limbs along with their girdles constitute the
(a) apendicular skeleton (b) axial skeleton
(c) apex skeleton (d) axis skeleton

74 Each human limb is made of
(a) 60 bones (b) 50 bones (c) 40 bones (d) 30 bones

75 Number of tarsals, metatarsals and phalanges in the hindlimbs of human are
(a) 7, 5,14 (b) 8, 5, 14 (c) 9, 5, 14 (d) 5, 6, 7

76 Which one is longest bone in human?
(a) Femur (b) Clavicle (c) Tibia (d) Ulna

77 A cup-shaped bone that covers the knee ventrally is called
(a) stapes (b) patella (c) malleus (d) incus

78 The triangular bone scapula is found on
(a) dorsal part of thorax between 2nd and 7th ribs
(b) ventral part of thorax between 2nd and 7th ribs
(c) medial part of thorax between 2nd and 7th ribs
(d) None of the above

79 Which of the following is a part of pectoral girdle?
(a) Ilium (b) Ischium
(c) Acetabulum (d) Glenoid cavity

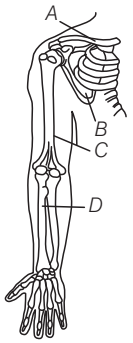
80 Glenoid cavity articulates ***CBSE-AIPMT 2015***
(a) clavicle with acromion (b) scapula with acromion
(c) clavicle with scapula (d) humerus with scapula

81 Pelvic girdle consists of
(a) ilium and clavicle (b) two coxal bones
(c) two acromion bones (d) acetabulum and glenoid cavity

82 Cavity in coxal bone called acetabulum is formed by the fusion of
(a) ilium and incus (b) ilium and ischium
(c) incus and ischium (d) ilium, ischium and pubis

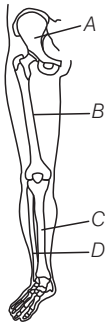
83 The two halves of the pelvic girdle meet ventrally to form
(a) fibrous pubic symphysis (b) fibrous pectoral symphysis
(c) elastic pelvic symphysis (d) elastic coxal bone

84 Examine the figure of right pectoral girdle and forelimb and identify the parts labelled as A, B, C and D.



	A	B	C	D
(a)	Clavicle	Scapula	Humerus	Radius
(b)	Scapula	Femur	Ulna	Tarsals
(c)	Clavicle	Femur	Radius	Carpals
(d)	Clavicle	Humerus	Ulna	Tarsals

85 Identify the parts labelled as A, B, C and D in the given figure of right pelvic girdle and lower limb bone.



	A	B	C	D
(a)	Coxal bone	Femur	Tibia	Fibula
(b)	Femur	Coxal bone	Tibia	Fibula
(c)	Fibula	Tibia	Coxal bone	Femur
(d)	Femur	Fibula	Tibia	Coxal bone

86 Pelvic girdle consists of two coxal bones and each coxal bone consists
I. Ilium II. Incus III. Ischium IV. Pubis
Choose the correct option containing all correct bones.
(a) I, II and III (b) II, III and IV
(c) I, III and IV (d) I, II and IV

87 A cricket player is fast chasing a ball in the field. Which one of the following groups of bones is directly contributing to this movement?
(a) Malleus, tibia, metatarsals, femur
(b) Pelvis, patella, tarsals, incus
(c) Sternum, femur, tibia, fibula
(d) Tarsals, femur, metatarsals, tibia

TOPIC 3 ~ *Joints*

88 Joints are point of contact between
(a) muscles and bones (b) two bones
(c) bones and cartilages (d) Both (b) and (c)

89 Fibrous joints are found in
(a) between flat bones of skull, i.e. sutures
(b) pubic symphysis
(c) between vertebrae
(d) All of the above

90 Cartilaginous joints in humans
(a) permit any movement (b) permit limited movement
(c) permit no movement (d) All of these

91 The cartilaginous joints contain
(a) hyaline cartilage (b) fibrous cartilage
(c) Both (a) and (b) (d) Either (a) or (b)

92 The pivot joint between atlas and axis is a type of ***NEET 2017***
(a) fibrous joint (b) cartilaginous joint
(c) synovial joint (d) saddle joint

93 The characteristics and an example of a synovial joint in humans is ***NEET 2013***

	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 movement	Gliding joint between carpals

94 Identify the synovial joints among the given options.
I. Ball and socket II. Hinge joint
III. Pivot joints IV. Sutures of skull
V. Vertebral joints
Select the correct option.
(a) I, II, III and IV (b) I, III, IV and V
(c) II, III, IV and V (d) I, II and III

95 Choose the incorrect pair.
(a) Facial bones – Made up of 14 skeletal elements
(b) Sacral vertebrae – One and fused
(c) Vertebrochondral ribs – False ribs (8th, 9th, 10th)
(d) Hinge joint – Adjacent lumbar vertebrae

96 Select the correct matching of the type of the joint with the example in human skeletal system. ***CBSE-AIPMT 2014***

	Types of Joint	Examples
(a)	Cartilaginous joint	Between frontal and parietal
(b)	Pivot joint	Between 3rd and 4th cervical vertebrae
(c)	Hinge joint	Between humerus and pectoral girdle
(d)	Gliding joint	Between carpals

97 The joint of humerus with pectoral girdle is
(a) hinge joint (b) pivot joint
(c) non-movable joint (d) ball and socket joint

98 Where is the saddle joint present in humans?
(a) Between carpals and metacarpals of thumb
(b) Between atlas and axis
(c) Between radius and ulna
(d) Between carpals and phallanges

TOPIC 4 ~ *Disorders of Muscular and Skeletal System*

99 Which of the following diseases is an autoimmune disorder? ***NEET (Odisha) 2019***
(a) Myasthenia gravis (b) Arthritis
(c) Osteoporosis (d) Gout

100 Which of the following muscular disorders is inherited? ***NEET (National) 2019***
(a) Muscular dystrophy (b) Myasthenia gravis
(c) Botulism (d) Tetany

101 In which of the following conditions, progressive degeneration of skeletal muscles happens?
(a) Myasthenia gravis (b) Muscular dystrophy
(c) Tetany (d) Arthritis

102 Lack of relaxation between successive stimuli in sustained muscle contraction is known as ***NEET 2016***
(a) fatigue (b) tetanus (c) tonus (d) spasm

103 Osteoporosis is
(a) an age-related disorder
(b) a gene related disorder
(c) a result of low Ca^{2+} ions in body
(d) None of the above

104 Bones become fragile in
(a) osteoporosis (b) gout
(c) arthritis (d) None of these

105 Joint pain, stiffness and swelling are the most common symptoms of
(a) gout (b) tetany
(c) arthritis (d) osteoporosis

106 Gout is caused due to the accumulation of
(a) glucose (b) uric acid crystals
(c) bile (d) ammonia

NEET

SPECIAL TYPES QUESTIONS

I. Assertion and Reason

■ **Direction** (Q. No. 107-115) *In each of the following questions, a statement of Assertion (A) is given by corresponding statement of Reason (R). Of the statements, mark the correct answer as*

(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true, but R is not the correct explanation of A
(c) If A is true, but R is false
(d) If A is false, but R is true

107 **Assertion** (A) Muscle fibre is a syncytium.
Reason (R) The sarcoplasm of muscle fibre contains numerous nuclei.

108 **Assertion** (A) On stimulation, a muscle cell releases calcium ions (Ca^{2+}) from sarcoplasmic reticulum.
Reason (R) By reacting with a protein complex, Ca^{2+} uncover active sites on the actin filaments.

109 **Assertion** (A) Red muscles fibres depend on anaerobic process for energy.
Reason (R) Red muscles fibres have more number of mitochondria in them.

110 **Assertion** (A) Calcium is required for skeletal muscle contraction. ***AIIMS 2019***
Reason (R) Calcium influx releases acetylcholine at neuromuscular junction.

111 **Assertion** (A) The myosin rich zone called A-band maintains its length during sarcomere contraction.
Reason (R) The length of I-band remains the same during muscle contraction.

112 **Assertion** (A) Knee joint is the hinge type of joint.
Reason (R) Femur and humerus are associated with the knee joint.

113 **Assertion** (A) The most abundant joints in human body are synovial joints.
Reason (R) Gliding joints offer movement in all the three planes/axis.

114 **Assertion** (A) The cranium and carpals are parts of axial skeleton.
Reason (R) Both carpals and cranium have 8 bones each.

115 **Assertion** (A) Human skull is dicondylic.
Reason (R) It is attached to vertebral column through two occipital condyles.

II. Statement Based Questions

116 Go through the following statements and choose the incorrect statement.
(a) All movements are locomotions, but all locomotions are not movements
(b) The tentacles of *Hydra* are locomotory in function
(c) In *Paramecium*, cilia help in the movement of food through cytopharynx
(d) Streaming of protoplasm in *Amoeba* is a type of amoeboid movement

117 Which of the following statements is/are true for ciliary movements?
(a) Cilia take part in the propulsion of excretory products
(b) Cilia are present in trachea, vasa efferentia and oviducts
(c) Cilia are seen in *Paramecium* and other ciliates
(d) All of the above

118 Choose the incorrect statement about muscles.
(a) Muscles are specialised tissues of mesodermal origin
(b) About 40-50% of the body weight is contributed by muscles
(c) Muscles have special properties like excitability, conductivity and extensibility
(d) None of the above

119 Choose the incorrect statement about the skeletal muscles.
(a) Their activities are under the voluntary control of the nervous system
(b) They are known as unstriated muscles
(c) They are primarily involved in locomotory actions and changes of body postures
(d) They are found close to skeletal components of body like bones

120 Select the incorrect statement.
(a) Voluntary movements in organism help in locomotion
(b) Pseudopodial movements as in *Amoeba* are shown by cytoskeletal elements like microfilaments
(c) Dust particles are removed from trachea due to the presence of ciliated epithelium on inner side
(d) All the cardiac muscles are unbranched, striated and involuntary in nature

121 Pick out the incorrect statement.

(a) Amount of myoglobin is high in red muscle fibres

(b) White muscle fibres possess low amount of sarcoplasmic reticulum

(c) Red muscle fibres contain abundant mitochondria

(d) White muscle fibres contain less amount of mitochondria

122 Select the correct option. ***NEET (National) 2019***

(a) 11th and 12th 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) 8th, 9th and 10th pairs of ribs articulate directly with the sternum

123 Choose the correct statement(s).

(a) Axial skeleton comprises 80 bones

(b) Skull, vertebral column, sternum and ribs constitute the axial skeleton

(c) Skull has total 22 bones in cranial and facial region

(d) All of the above

124 Select the incorrect statement.

(a) Each half of pectoral girdle consists of a clavicle and scapula

(b) Acromion is a flat, expanded process of ischium containing glenoid cavity

(c) Clavicle is a long slender bone with two curvatures

(d) Force generated by muscles results in locomotion through joints and thus, they act as fulcrum

125 Select the correct statement regarding the specific disorder of muscular or skeletal system. ***CBSE-AIPMT 2016***

(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 –Autoimmune disorder which inhibits sliding of myosin filaments

(d) Gout–Inflammation of joints due to extra deposition of calcium

126 Select the correct statement with respect to locomotion in humans. ***NEET 2013***

(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

127 Consider the following statements.

I. Human ribs are bicephalic as they possess two articulation surfaces.

II. Floating ribs are not connected to sternum ventrally.

Select the correct option.

(a) I is true, II is false (b) Both I and II are true

(c) I is false, II is true (d) Both I and II are false

128 Which of the following properties of cardiac muscles are correct?

I. These are the muscles of the heart.

II. These are non-striated.

III. These are involuntary in their functions.

IV. These are controlled by nervous system directly.

Select the correct option.

(a) I and III (b) II and IV

(c) I and IV (d) II and III

129 Consider the following statements.

I. Ciliary movements are observed in internal tubular organs.

II. All muscle bundles contain a number of fascia.

Select the correct option.

(a) I is true, II is false

(b) Both I and II are true

(c) I is false, II is true

(d) Both I and II are false

130 Consider the following statements.

I. Muscle fibre is lined by the plasma membrane called sarcolemma.

II. Cytoplasm of the muscle fibre contains single nucleus.

III. In muscle fibre, F-actin and tropomyosin are helically wound filaments.

IV. Muscle fibre is not a syncytium.

Choose the incorrect properties of muscle fibres.

(a) II and IV (b) I and III

(c) III and IV (d) I and IV

131 Which of the following statements are false regarding the muscle structure?

I. Each myofibril consists of alternate light and dark bands.

II. Thin filaments are firmly attached to the Z-line.

III. M-line is a fibrous membrane in the middle of A-band.

IV. Both actin and myosin are rod-like structures parallel to each other and to longitudinal axis of myofibril.

Choose the correct option.

(a) I and II (b) III and IV

(c) II and III (d) None of these

132 Consider the following statements.

I. In resting state, edges of thin filament partially overlap the ends of thick filament.

II. H-zone is the overlapped area of thick and thin filaments.

Select the correct option.

(a) I is true, II is false (b) Both I and II are true
(c) I is false, II is true (d) Both I are II are false

133 Consider the following statements with reference to muscle structure.

I. Each myosin is a polymerised protein.

II. Many meromyosins constitute one thick filament (myosin).

III. Each meromyosin's tail is called Heavy Meromyosin (HMM) and head is called Light Meromyosin (LMM).

IV. The globular head is an active ATPase enzyme and has binding sites for ATP and active sites for actin.

Choose the option with correct statements.

(a) I and II (b) III and IV
(c) All except III (d) I and IV

134 Select the incorrect statements.

I. During muscle contraction, chemical energy changes into mechanical energy.

II. Muscle fatigue occurs due to pyruvic acid formation.

III. The reaction time is different for different muscle.

IV. Muscle contraction does not need ATP.

Choose the correct option.

(a) I and II (b) II and III
(c) III and IV (d) II and IV

135 Identify the correct statements.

I. Acetylcholine is released when the neural signal reaches to the motor end-plate.

II. Muscle contraction is initiated by signals sent by CNS *via* a sensory neuron.

III. During muscle contraction, isotropic bands get elongated.

IV. Repeated activation of the muscles can lead to lactic acid accumulation in them.

Select the correct option.

(a) I and III (b) I and IV (c) II and III (d) I and II

136 Arrange the given steps of muscle contraction in the series of events from first to last.

I. Myosin head binds to the exposed active site on actin to form a cross-bridge.

II. The Z-line attached to these actins are also pulled inwards thereby, causing shortening of sarcomere, also called contraction.

III. This pulls the attached actin filaments towards the centre of A-band.

The correct option is

(a) I → II → III (b) III → II → I
(c) I → III → II (d) III → I → II

137 Arrange the following steps of muscle contraction in the sequence of events occurring first.

I. Receptor sites on sarcolemma

II. Nerve impulse

III. Release of Ca^{2+}

IV. Acetylcholine release

V. Shortening of sarcomere

VI. Neuromuscular junction

VII. Spread of impulse over sarcolemma on T-tubule

The correct option is

(a) II → VI → IV → I → VII → III → V
(b) II → IV → I → VI → VII → III → V
(c) II → IV → I → VI → VII → V → III
(d) IV → II → I → VI → VII → V → III

138 Relaxation of the muscle takes place due to

I. Pumping of Ca^{2+} ions in sarcoplasmic reticulum.

II. ATP attached to myosin head and cross-bridge breaks down.

III. Confirmational changes in troponin and masking the actin filament.

IV. Z-line pulled inward.

Select the correct option.

(a) I, III and IV (b) I and II
(c) II, III and IV (d) I, II and III

139 Study the following statements.

I. Accumulation of acetic acid in muscles causes fatigue.

II. Accumulation of lactic acid in muscles causes anaerobic breakdown of glycogen.

III. Mitochondria are few in white fibres, but amount of sarcoplasmic reticulum is high.

IV. Cori cycle does not occur in muscles.

Select the option with incorrect statements.

(a) I, II and III (b) I, III and IV
(c) I, II and IV (d) II, III and IV

III. Matching Type Questions

140 Match the following columns.

Column I (Ribs)	**Column II** (Number in pairs)
A. True ribs	1. 11, 12 pairs
B. False ribs	2. 8, 9, 10 pairs
C. Floating ribs	3. First 7 pairs

Codes

	A	B	C		A	B	C
(a)	1	2	3	(b)	1	3	2
(c)	3	2	1	(d)	3	1	2

141 Match the following columns.

	Column I (Limb bones)		Column II (Number)
A.	Ulna	1.	14 bones
B.	Carpals	2.	5 bones
C.	Metacarpals	3.	8 bones
D.	Phalanges	4.	1 bone

Codes

	A	B	C	D		A	B	C	D
(a)	3	4	1	2	(b)	4	3	2	1
(c)	4	1	2	3	(d)	3	2	1	4

142 Match the following columns.

	Column I		Column II
A.	Flat bones	1.	Collar bone
B.	Irregular bones	2.	Vertebrae
C.	Glenoid cavity	3.	Shoulder joint
D.	Clavicle	4.	Ear ossicles

Codes

	A	B	C	D		A	B	C	D
(a)	2	4	3	1	(b)	3	2	4	1
(c)	1	4	3	2	(d)	3	4	2	1

143 Match the following columns.

	Column I (Location)		Column II (Bones)
A.	Hand	1.	Femur
B.	Wrist	2.	Radius
C.	Thigh	3.	Carpal
D.	Ankle	4.	Tarsals

Codes

	A	B	C	D
(a)	2	3	1	4
(b)	4	3	1	2
(c)	3	2	1	4
(d)	3	1	2	4

144 Match the following columns.

	Column I (Types of vertebrae)		Column II (Number)
A.	Cervical vertebrae	1.	1
B.	Thoracic vertebrae	2.	1
C.	Lumbar vertebrae	3.	5
D.	Sacral vertebrae	4.	12
E.	Caudal vertebrae	5.	7

Codes

	A	B	C	D	E
(a)	1	2	3	4	5
(b)	5	4	3	2	1
(c)	5	3	4	2	1
(d)	1	3	2	5	4

145 Match the following columns.

	Column I (Joints)		Column II (Location)
A.	Fibrous joints	1.	Adjacent vertebrae
B.	Cartilaginous joints	2.	Pubic symphysis
C.	Fibrous cartilaginous joint	3.	Sutures

Codes

	A	B	C		A	B	C
(a)	1	2	3	(b)	2	3	1
(c)	3	1	2	(d)	2	1	3

146 Match the following columns.

	Column I (Bones)		Column II (Number)
A.	Tarsals	1.	5 in number
B.	Metatarsals	2.	8 in number
C.	Phalanges	3.	14 in number
D.	Carpals	4.	7 in number

Codes

	A	B	C	D		A	B	C	D
(a)	1	3	2	4	(b)	4	1	3	2
(c)	4	1	2	3	(d)	1	4	3	2

147 Match the following joints with the bones involved.

NEET (Odisha) 2019

	Column I		Column II
A	Gliding joint	1.	Between carpals and metacarpal of thumb
B	Hinge joint	2.	Between atlas and axis
C	Pivot joint	3.	Between the carpals
D	Saddle joint	4.	Between humerus and ulna

Codes

	A	B	C	D		A	B	C	D
(a)	3	4	2	1	(b)	4	1	2	3
(c)	4	2	3	1	(d)	1	3	2	4

148 Match the following columns.

	Column I (Disorders)		Column II (Features)
A.	Myasthenia gravis	1.	Degeneration of skeletal muscles
B.	Muscular dystrophy	2.	Neuromuscular junction affected
C.	Tetany	3.	Low Ca^{2+} in body fluid
D.	Arthritis	4.	Inflammation of joints

Codes

	A	B	C	D		A	B	C	D
(a)	4	2	3	1	(b)	1	3	4	2
(c)	3	4	1	2	(d)	2	1	3	4

NCERT & NCERT Exemplar

MULTIPLE CHOICE QUESTIONS

NCERT

149 Match Column I with Column II.

	Column I		Column II
A.	Smooth muscle	1.	Myoglobin
B.	Tropomyosin	2.	Thin fillament
C.	Red muscle	3.	Sutures
D.	Skull	4.	Involuntary

Codes

	A	B	C	D		A	B	C	D
(a)	4	2	1	3	(b)	4	1	2	3
(c)	3	1	4	2	(d)	1	2	3	4

NCERT Exemplar

150 Match the following columns.

	Column I		Column II
A.	Fast muscle fibres	1.	Myoglobin
B.	Slow muscle fibres	2.	Lactic acid
C.	Actin filament	3.	Contractile unit
D.	Sarcomere	4.	I-band

Codes

	A	B	C	D		A	B	C	D
(a)	1	2	4	3	(b)	2	1	3	4
(c)	2	1	4	3	(d)	3	2	4	1

151 Ribs are attached to
(a) scapula (b) sternum
(c) clavicle (d) ilium

152 What is the type of movable joint present between the atlas and axis?
(a) Pivot (b) Saddle
(c) Hinge (d) Gliding

153 ATPase of the muscle is located in
(a) actinin (b) troponin (c) myosin (d) actin

154 Intervertebral disc is found in the vertebral column of
(a) birds (b) reptiles
(c) mammals (d) amphibians

155 Which one of the following is showing the correct sequential order of vertebrae in the vertebral column of human beings?
(a) Cervical — Lumbar — Thoracic — Sacral — Coccygeal
(b) Cervical — Thoracic — Sacral — Lumbar — Coccygeal
(c) Cervical — Sacral — Thoracic — Lumbar — Coccygeal
(d) Cervical — Thoracic — Lumbar — Sacral — Coccygeal

156 Which one of the following pair is incorrect?
(a) Hinge joint – between humerus and pectoral girdle
(b) Pivot joint – between atlas, axis and occipital condyle
(c) Gliding joint – between the carpals
(d) Saddle joint – between carpals and metacarpal of thumb

157 Knee joint and elbow joint are examples of
(a) saddle joint (b) ball and socket joint
(c) pivot joint (d) hinge joint

158 Macrophages and leucocytes exhibit
(a) ciliary movement (b) flagellar movement
(c) amoeboid movement (d) gliding movement

159 Which one of the following is not a disorder of bone?
(a) Arthritis (b) Osteoporosis
(c) Rickets (d) Atherosclerosis

160 Which one of the following statements is incorrect?
(a) Heart muscles are striated and involuntary
(b) The muscles of hands and legs are striated and voluntary
(c) The muscles located in the inner walls of alimentary canal are striated and involuntary
(d) Muscles located in the reproductive tracts are unstriated and involuntary

161 Which one of the following statements is true?
(a) Head of humerus bone articulates with acetabulum of pectoral girdle
(b) Head of humerus bone articulates with glenoid cavity of pectoral girdle
(c) Head of humerus bone articulates with a cavity called acetabulum of pelvic girdle
(d) Head of humerus bone articulates with glenoid cavity of pelvic girdle

162 Muscles with characteristic striations and involuntary are
(a) muscles in the wall of alimentary canal
(b) muscles of the heart
(c) muscles assisting locomotion
(d) muscles of the eyelids

163 Match the following columns.

	Column I		Column II
A.	Sternum	1.	Synovial fluid
B.	Glenoid cavity	2.	Vertebrae
C.	Freely movable joint	3.	Pectoral girdle
D.	Cartilaginous joint	4.	Flat bone

Codes

	A	B	C	D		A	B	C	D
(a)	2	1	3	4	(b)	4	3	1	2
(c)	2	1	4	3	(d)	4	1	2	3

Answers

Mastering NCERT with MCQs

1 (a)	2 (a)	3 (b)	4 (c)	5 (c)	6 (d)	7 (d)	8 (b)	9 (b)	10 (d)
11 (c)	12 (c)	13 (a)	14 (c)	15 (d)	16 (b)	17 (a)	18 (a)	19 (b)	20 (c)
21 (b)	22 (b)	23 (a)	24 (c)	25 (b)	26 (a)	27 (c)	28 (b)	29 (d)	30 (b)
31 (c)	32 (a)	33 (a)	34 (c)	35 (b)	36 (a)	37 (c)	38 (c)	39 (b)	40 (c)
41 (a)	42 (c)	43 (c)	44 (b)	45 (c)	46 (b)	47 (c)	48 (c)	49 (b)	50 (a)
51 (a)	52 (a)	53 (a)	54 (c)	55 (c)	56 (d)	57 (d)	58 (b)	59 (d)	60 (a)
61 (b)	62 (b)	63 (b)	64 (a)	65 (d)	66 (d)	67 (a)	68 (b)	69 (b)	70 (a)
71 (b)	72 (d)	73 (a)	74 (d)	75 (a)	76 (a)	77 (b)	78 (a)	79 (d)	80 (d)
81 (b)	82 (d)	83 (a)	84 (a)	85 (a)	86 (c)	87 (d)	88 (d)	89 (a)	90 (b)
91 (d)	92 (c)	93 (c)	94 (d)	95 (d)	96 (d)	97 (d)	98 (a)	99 (a)	100 (a)
101 (b)	102 (b)	103 (a)	104 (a)	105 (c)	106 (b)				

NEET Special Types Questions

107 (a)	108 (b)	109 (d)	110 (c)	111 (c)	112 (c)	113 (c)	114 (d)	115 (a)	116 (a)
117 (d)	118 (d)	119 (b)	120 (d)	121 (b)	122 (c)	123 (d)	124 (b)	125 (b)	126 (b)
127 (b)	128 (a)	129 (a)	130 (a)	131 (d)	132 (a)	133 (c)	134 (d)	135 (b)	136 (c)
137 (a)	138 (d)	139 (c)	140 (c)	141 (b)	142 (a)	143 (a)	144 (b)	145 (c)	146 (b)
147 (a)	148 (d)								

NCERT & NCERT Exemplar Questions

149 (a)	150 (c)	151 (b)	152 (a)	153 (c)	154 (c)	155 (d)	156 (a)	157 (d)	158 (c)
159 (d)	160 (c)	161 (b)	162 (b)	163 (b)					

Answers & Explanations

5 (*c*) Movement of limbs, jaws, tongue, etc., requires muscular movement. The contractile property of the muscles is effectively used for locomotion and other movements by human beings and majority of multicellular organisms.

8 (*b*) Locomotory actions within human body are carried out using striated muscles or skeletal muscles. These muscles are closely associated with the skeletal components of the body and are primarily involved in locomotory actions and changes of body postures.

9 (*b*) Visceral muscles are likely to be found in the inner walls of hollow visceral organs of the body like digestive tract, reproductive tract, etc. These do not exhibit any striation and are smooth in appearance. Hence, they are called smooth muscles and non-striated muscles.

15 (*d*) Calcium performs all the given functions, i.e. blood clotting, muscular contraction and nerve conduction. Ca^{2+} ions are helpful in the formation of prothrombinase which catalyses the breakdown of prothrombin into thrombin and small peptide fragments. Thrombin in turn is important for the clotting of blood. Calcium plays a key regulatory role in muscle contraction. It helps in exposing the active sites on the F-actin molecules for myosin cross-bridges. Calcium ions help in the transmission of nerve impulse at a chemical synapse.

17 (*a*) Myofibrils appear striated due to the presence of actin in lighter region and myosin in darker region. Each myofibril has an alternate dark and light band on it, due to the distribution pattern of two important proteins, i.e. actin and myosin in these regions.

20 (*c*) The pair in option (c) is incorrect. Its correct form is as follows

Dark bands are called A-bands or Anisotropic bands whereas light bands are Isotropic or I-bands.

Rest of the pairs are correctly matched.

21 (*b*) In the centre of each I-band, there is an elastic fibre called Z-line, which bisects it. The thin filaments are firmly attached to the Z-line.

24 (*c*) The H-zone in the skeletal muscle fibres is the central gap between actin filaments extending through myosin filaments in the A-band. Alternate arrangement of dark and light bands gives the striated appearance to a skeletal muscle. At the centre of A-band, a comparatively less dark zone called H-zone is present.

25 (*b*) Each actin (thin) filament is made up of two F- (filamentous) actins, which are helically wound to each other. Each F-actin is a polymer of monomeric G (globular) actins.

29 (*d*) The pair in option (d) is incorrectly matched. Its corrected form is as follows

Troponin is a complex protein distributed at regular intervals on tropomyosin.

Rest of the pairs are correctly matched.

30 (*b*) The cross arms of myosin monomer consists of a head and short arm which projects outwards at regular distance and angle from each other, from the surface of polymerised myosin filament. The globular head is an active ATPase enzyme and has binding sites for ATP and active sites for actin.

31 (*c*) Active (binding) sites for actin are located on the globular head of a meromyosin. The globular head is an active ATPase enzyme which contains binding sites for both ATP and actin.

35 (*b*) Mechanism of muscle contraction is best explained by the sliding filament theory. It states that the contraction of a muscle fibre takes place by the sliding of the thin filaments over the thick filaments.

36 (*a*) Skeletal muscle contraction is initiated by a signal sent by Central Nervous System (CNS), *via* motor neurons. A motor neuron along with the muscle fibres connected to it constitute a motor unit.

39 (*b)* A neural signal reaching neuromuscular junction releases a neurotransmitter, i.e. acetylcholine. It generates an action potential in the sarcolemma. This spreads through the muscle fibre and causes the release of calcium ions into the sarcoplasm.

43 (*c*) Calcium is important in skeletal muscle contraction because it binds to troponin to unmask/expose the active sites on actin for myosin binding. By utilising the energy from ATP hydrolysis, the myosin head now binds to the exposed active sites on actin to form a cross-bridge.

This pulls the attached actin filaments towards the centre of A-band and the Z-line attached to these actins are also pulled inwards thereby, causing contraction of muscle.

45 (*c*) A-band or Anisotropic band remains unchanged during the contraction and relaxation of the skeletal muscles. The H-zone narrows and even disappears when the thin myofilaments meet at the centre of the sarcomere. The size of I-band also decreases.

48 (*c*) Sliding of actin and myosin filaments continues till the Ca^{2+} ions are pumped back to the sarcoplasmic cisternae, resulting in the masking of actin filaments. This causes the return of Z-lines back to their original position, i.e. relaxation of muscle fibre.

49 (*b*) Muscles contain a red coloured oxygen containing pigment called the myoglobin. It is abundantly found in the red muscle fibres than white muscle fibres.

56 (*d*) The number of bones in the parts of human skull such as carnial bones, facial bones, hyoid bones and middle ear bones are 8, 14, 1 and 6, respectively.

Cranial bones are 8 in number, which form the hard protective outer covering cranium for the brain. The facial region is made up of 14 bones which form the front part of the skull.

A single U-shaped bone called hyoid (1) is present at the base of the buccal cavity and it is also included in the skull. Each middle ear contains three tiny bones, malleus (2), incus (2) and stapes (2), collectively called ear ossicles.

60 (*a*) Our vertebral column is formed by 26 serially arranged units called vertebrae. The vertebral column is differentiated into cervical (7), thoracic (12), lumbar (5), sacral (1-fused) and coccygeal (1-fused) regions starting from the skull.

64 (*a*) Atlas is the first cervical vertebrae of the spine. It articulates with the occipital condyles and forms the joint connecting the skull and spine.

70 (*a*) In the rib cage, out of the 12 (X) pairs of ribs, 7 (Y) pairs of ribs are called true ribs. These are the ribs which are attached to the sternum at the front (ventrally) and to the vertebral column at the back (dorsally).

71 (*b*) The 8th, 9th and 10th pairs of ribs do not articulate directly with the sternum but are joined to the 7th pair of ribs with the help of hyaline cartilage. Thus, these are called the vertebrochondral or false ribs.

73 (*a*) Bones of the limbs along with their girdles constitute the appendicular skeleton. It consists of 126 bones.

78 (*a*) Scapula is a large triangular flat bone situated in the dorsal part of the thorax between the 2nd and the 7th ribs.

The dorsal, flat, triangular body of the scapula has a slightly elevated ridge called the spine which projects as a flat, expanded process called the acromion.

79 (*d*) Out of the given options, glenoid cavity is a part of the pectoral girdle. Pectoral girdle or Shoulder girdle is composed of two separate halves. Each half consists of the scapula of shoulder bone and clavicle or collar bone. At the junction of scapula and clavicle, there is a concave depression, called glenoid cavity, which articulates with the head of the humerus to form a ball and socket joint.

Ilium, acetabulum and ischium are the parts of pelvic girdle.

80 (*d*) Glenoid cavity articulates humerus with scapula.

It is shallow and serves as the site of attachment of glenoid labrum (glenoid ligament), which forms fibrocartilaginous rim around the glenoid cavity.

82 (*d*) Cavity in coxal bone called acetabulum is formed at the site of fusion of ilium, ischium and pubis.

83 (*a*) Two halves of pelvic girdle meet ventrally to form the pubic symphysis containing fibrous cartilage.

87 (*d*) A cricket player is fast chasing a ball in the field. The group of bones directly contributing to this movement

are tarsals, femur, metatarsals and tibia. These are the bones of lower limbs.

89 (*a*) Fibrous joints are found in between the flat bones of skull, i.e. sutures. These are immovable or fixed joints (do not allow any movement). These sutures are formed by the end-to-end fusion of the bone with the help of dense fibrous connective tissue.

91 (*d*) The cartilaginous joints either contain hyaline cartilage, e.g. in between ribs and sternum or fibrous cartilage, e.g. in pubic symphysis.

92 (*c*) The pivot joint between atlas and axis is a type of synovial joint. A considerable movement is allowed by synovial joints. These are surrounded by tubular articular capsule.

The capsule consists of two layers, i.e. outer fibrous capsule and inner synovial membrane, which secretes synovial fluid. This fluid lubricates and provides nourishment to articular cartilage.

93 (*c*) Option (c) shows the correct match.

Other options are incorrect and can be corrected as

- Knee joints and gliding joints between carpals are also examples of synovial joints.
- Joints between the bones of skull are example of fibrous joints which are characterised by lack of movement.

95 (*d*) The pair in option (d) is incorrect. Its correct explanation is as follows

Hinge joint is found in knees. The joint between the adjacent vertebrae in the vertebral column is cartilaginous joint and permits limited movements. Rest of the pairs are correctly matched.

96 (*d*) Option (d) shows the correct match.

Other options are incorrect and can be corrected as

- Cartilaginous joint is found between the vertebrae.
- Pivot joint is found between atlas and axis.
- Hinge joint is found in elbow, knee, ankle and interphalangeal joints.

99 (*a*) Myasthenia gravis is a chronic autoimmune neuromuscular disorder that causes weakness, fatigue and paralysis in the skeletal fibres that are involved in breathing and many various parts of the body including arms and legs.

101 (*b*) Muscular dystrophy is an inherited muscular disorder in which the skeletal muscles degenerate progressively. It is caused due to the absence of dystrophin protein which helps to keep the muscle cells intact.

102 (*b*) Sustained muscle contraction due to the repeated stimulus caused by rapid spasms in muscle due to low Ca^{2+} in body fluid is known as tetanus. It results in muscle fatigue.

103 (*a*) Osteoporosis is an age-related disorder characterised by decreased bone mass as bones loose minerals and fibres from the matrix causing decreased bone mass and increased chances of fractures. Decreased level of oestrogen is a common cause of this disease.

104 (*a*) Bones become fragile in osteoporosis, due to the reduction in bone tissue mass and this causes a decrease in skeletal strength.

108 (*b*) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion. Its correct explanation is as follows

A neural signal reaching the neuromuscular junction releases a neurotransmitter (acetylcholine) which generates an action potential in the sarcolemma. This spreads through the muscle fibre and causes the release of calcium ions into the sarcoplasm.

Increase in Ca^{+} levels leads to the binding of calcium to the subunit of troponin on actin filaments and thereby removes the masking of active sites for myosin.

109 (*d*) Assertion is false, but Reason is true. Assertion can be corrected as

Red muscle fibres have more number of mitochondria but less sarcoplasmic reticulum. These fibres are dark red in colour due to the presence of myoglobin. These carry out aerobic respiration.

White muscle fibres possess very less quantity of myoglobin and appear pale or whitish. Number of mitochondria are also few in them, but the amount of sarcoplasmic reticulum is huge. These depend on anaerobic process for energy.

110 (*c*) Assertion is true, but Reason is false and can be corrected as

Calcium ions are required for skeletal contraction. Sarcoplasmic reticulum releases Ca^{+} on receiving stimulus at the neuromuscular junction or motor end plate. When a neural signal reaches the neuromuscular junction, a neurotransmitter called acetylcholine is released at this junction and generates an action potential in the sarcolemma. This spreads throughout the muscle fibre and causes the release of the calcium ions into the sarcoplasm.

111 (*c*) Assertion is true, but Reason is false and can be corrected as

The length of the I-band shortens during muscle contraction.

The formation of cross-bridges causes the pulling of the attached actin filaments towards the centre of A-band. The Z-line attached to these actins are also pulled inwards thereby, causing a shortening of the sarcomere, i.e. contraction. During the shortening of the muscle, the I-bands get reduced, whereas the A-bands retains its length.

112 (*c*) Assertion is true, but Reason is false. Reason can be corrected as

Femur, tibia, fibula and patela are the bones which make up the knee joint.

113 (*c*) Assertion is true, but Reason is false. Reason can be corrected as

Gliding joints offer movement only in one plane or axis like back and forth and side-to-side movements.

The most abundant joints in human body are synovial joints. These are characterised by the presence of a fluid

filled synovial cavity between the articulating surfaces of the two bones. These joints help in locomotion and many other movements. These include ball and socket joint, hinge joint, pivot joint, gliding joint, etc.

114 (*d*) Assertion is false, but Reason is true and Assertion can be corrected as

Carpals or Wrist bones are a part of the appendicular skeleton. Cranium is part of the axial skeleton which forms the hard protective outer covering for the brain.

Both carpals and cranium bones are 8 in number.

116 (*a*) The statement in option (a) is incorrect and can be corrected as

All locomotions are movements, but all movements are not locomotion. Locomotion is a voluntary movement that results in change of place or location. However, movement in the alimentary canal is not locomotion as it is involuntary in nature.

Rest of the statements are correct.

119 (*b*) The statement in option (b) is incorrect about the skeletal muscles and can be corrected as

Skeletal muscles are closely associated with the skeletal components of the body. These have a striped appearance under the microscope and hence, are called striated muscles.

Rest of the statements are correct.

120 (*d*) The statement in option (d) is incorrect. It can be corrected as

Cardiac muscles are the muscles of heart. Many cardiac muscle cells assemble in a branching pattern to form a cardiac muscles and are thus branched. Based on appearance, cardiac muscles are striated and are also involuntary in nature.

Rest of the statements are correct.

121 (*b*) The statement in option (b) is incorrect. It can be corrected as

White muscle fibres contain abundant sarcoplasmic reticulum, but very less amount of mitochondria. These muscle fibres depend on anaerobic process for energy.

Rest of the statements are correct.

122 (*c*) The statement in option (c) is correct.

Rest of the statements are incorrect and can be corrected as

- Vertebrosternal ribs are first seven pairs of true ribs which are attached dorsally to thoracic vertebrae and ventrally to the sternum.
- Vertebrochondral ribs (8th, 9th, 10th pairs) are false ribs which are not attached to sternum directly. These are attached to the seventh rib with the help of hyaline cartilage.
- Vertebral ribs are the last two pairs of floating ribs which are attached to vertebrae dorsally and are not attached ventrally.

124 (*b*) The statement in option (b) is incorrect and can be corrected as

Scapula has an elevated ridge called the spine which projects as flat, expanded process called the acromion. The clavicle articulates to this and below acromion, glenoid cavity is present, which articulates with the head of the humerus to form the shoulder joint.

125 (*b*) The statement in option (b) is correct regarding the specific disorder of the muscular or skeletal system. Other statements are incorrect and can be corrected as follows

- Muscular dystrophy is a genetic disorder characterised by progressive weakness and degeneration of the skeletal muscles that control movement.
- Myasthenia gravis is a neuromuscular autoimmune disorder that causes weakness in the skeletal muscles.
- Gout is a form of arthritis, characterised by severe pain, redness and tenderness in joints.

126 (*b*) Statement in option (b) is correct with respect to locomotion in humans. Other statements are incorrect and can be corrected as

- A decreased level of oestrogen causes osteoporosis in old people.
- The vertebral column has 7 cervical vertebrae, 12 throacic vertebrae, 5 lumbar vertebrae and a sacral (1-fused) and a coccygeal (1-fused) vertebrae.
- The joint between the adjacent vertebrae in the vertebral column is cartilaginous and not fibrous joint. Fibrous joints are shown by the flat skull bones.

128 (*a*) Statements I and III are correct regarding the properties of cardiac muscles. Statements II and IV are incorrect and can be corrected as

- Many cardiac muscle cells assemble in a branching pattern to form a cardiac muscle. Based on appearance, these are striated.
- These are involuntary in nature as the nervous system does not control their activities directly.

129 (*a*) Statement I is true, but statement II is false. It can be corrected as

Each muscle bundle contains a number of muscle fibres.

Each skeletal muscle is made up of a number of muscle bundles or fascicles held together by a common collagenous connective tissue layer called fascia.

130 (*a*) Statements II and IV are incorrect regarding muscle fibres and can be corrected as

Muscle fibre is a syncytium as the sarcoplasm (cytoplasm of the muscle fibre) contains many nuclei.

Statements I and III are correct.

132 (*a*) Statement I is true, but statement II is false. The statement II can be corrected as

H-zone is the central part of the thick filament, which is not overlapped by the thin filaments.

133 (*c*) All statements except statement III are correct with reference to muscle structure. The incorrect statement can be corrected as
Each meromyosin has a globular head with a short arm (Heavy Meromyosin or HMM) and a tail (Light Meromyosin or LMM).

134 (*d*) Statements I and III are correct, while statements II and IV are incorrect. These can be corrected as
- Muscle fatigue occurs due to lactic acid formation.
- Muscle contraction requires ATP for the formation and breakdown of cross-bridges.

135 (*b*) Statements I and IV are correct, whereas statements II and III are incorrect. These incorrect statements can be corrected as
- Muscle contraction is initiated by singals sent by CNS *via* a motor neuron.
- During muscle contraction, I (isotropic) bands get reduced, whereas the A (anisotropic) bands retain its length.

138 (*d*) The statements I, II and III are correct regarding relaxation of the muscle. Statement IV is incorrect and can be corrected as
The Z-line attached to actins is pulled inwards during contraction of muscle.

139 (*c*) Statements I, II and IV are incorrect. These can be corrected as
- Accumulation of lactic acid in muscles causes muscle fatigue.
- Repeated activation of muscles can lead to the accumulation of lactic acid due to anaerobic breakdown of glycogen in them, causing fatigue.
- Cori cycle is a cyclic process involving the formation of lactic acid in the muscles and regeneration of glycogen from it (in the liver). Statement III is the correct statement.

153 (*c*) ATPase of muscles is located in myosin. The globular head of myosin in muscles contains the active ATPase enzyme having binding sites for ATP and active sites for actin.

154 (*c*) Intervertebral disc is found in the vertebral column of mammals. These are present between the bodies of adjacent vertebrae from second cervical vertebra to the sacrum.

155 (*d*) The vertebral column is differentiated into Cervical (7), Thoracic (12), Lumbar (5), Sacral (1-fused), Coccygeal (1-fused) and regions starting from the skull.
Thus, option (d) represents the correct sequence.

156 (*a*) The pair in option (a) is incorrect. It can be corrected as
Hinge joint is found in knees, elbows, etc.
Ball and socket joint is found between humerus and pectoral girdle.
Rest of the pairs are correctly matched.

158 (*c*) Some specialised cells in blood like macrophages and leucocytes exhibit amoeboid movement. These have the ability to reach the interstitial fluid by squeezing through the thin walls of blood vessels.

159 (*d*) Atherosclerosis is a vascular disease (not a bone disorder), where arteries wall get thicken as a result of invasion and accumulation of WBCs, containing both livings active WBCs (White Blood Cells) and remnants of dead WBCs along with cholesterol and triglycerides.
Arthritis, osteoporosis and rickets are disorders of bones.

160 (*c*) Statement in option (c) is incorrect. It can be corrected as
The visceral or smooth muscles located in the inner walls of alimentary canal are non-striated and involuntary in nature.
Rest of the statements are correct.

161 (*b*) Statement in option (b) is correct.
Rest of the statements are incorrect and can be corrected as
Head of humerus bone articulates with the glenoid cavity of the pectoral girdle.
This results in the formation of shoulder joint (a type of ball and socket joint). The thigh bone articulates with the cavity, acetabulum of the pelvic girdle.