Zoology

# Locomotion and Movement

## Trend Analysis NEET

| | NEET | Remarks |
|---|---|---|
| Number of Questions from 2024-18 | 16 | 2-3 Questions every year |
| Weightage | 2.4% | |

| | | | NEET | |
|---|---|---|---|---|
| Year | Topic Name | Concept Used | No. of Questions | Difficulty Level |
| 2024 | Joints | Types of Joints | 1 | Average |
| 2023 | Muscle/ Joints | Muscle Contraction | 2 | Average |
| 2022 | Disorders of Muscular and Skeletal System | Muscular Disorder | 2 | Difficult/ Average |
| 2021 | Muscle | Muscle contraction | 3 | Average |
| 2020 | Skeletal System & Joints | Ribs | 1 | Difficult |
| 2019 | Skeletal System & Joints/ Disorders of Muscular and Skeletal system | Ribs/ Muscular Disorder | 3 | Average/ Difficult |
| 2018 | Types of Movement & Muscle | Muscle contraction | 4 | Average |

## NCERT ONE-LINERS
(Important Points to Remember)

### 17.0 Introduction

- Animals and plants exhibit a wide range of movements.
- Streaming of protoplasm in the unicellular organisms like Amoeba is a simple form of movement.
- Movement of cilia, flagella and tentacles are shown by many organisms.
- Human beings can move limbs, jaws, eyelids, tongue, etc.
- The movements that result in a change of place or location. Such voluntary movements are called **locomotion**.
- Walking, running, climbing, flying, swimming are all some forms of locomotory movements.
- Locomotory structures need not be different from those affecting other types of movements. Such as in *Paramoecium*, cilia helps in the movement of food through **cytopharynx** and in locomotion as well.
- *Hydra* can use its tentacles for capturing its prey and also use them for locomotion. Human beings use limbs for changes in body postures and locomotion as well.
- All locomotions are movements but all movements are not locomotions.
- Methods of locomotion performed by animals vary with their habitats and the demand of the situation.
- Locomotion is generally for search of food, shelter, mate, suitable breeding grounds, favourable climatic conditions or to escape from enemies/predators.

### 17.1 Types of Movement

- Cells of the human body exhibit three main types of movements, namely, **amoeboid**, **ciliary** and **muscular**.
- Some specialised cells in our body like macrophages and leucocytes in blood exhibit amoeboid movement. It is effected by pseudopodia formed by the streaming of protoplasm such as in Amoeba.
- Cytoskeletal elements like microfilaments are also involved in amoeboid movement.
- Ciliary movement occurs in most of our internal tubular organs which are lined by **ciliated epithelium**.
- The coordinated movements of cilia in the trachea help us in removing dust particles and some of the foreign substances inhaled alongwith the atmospheric air.
- Passage of ova through the female reproductive tract is also facilitated by the ciliary movement.
- Movement of our limbs, jaws, tongue, etc, require muscular movement.
- The contractile property of muscles are effectively used for locomotion and other movements by human beings and majority of multicellular organisms.
- Locomotion requires a perfect coordinated activity of muscular, skeletal and neural systems.

## 17.2 Muscle

- The cilia and flagella are the outgrowths of the cell membrane.
- **Flagellar movement** helps in the swimming of spermatozoa, maintenance of water current in the canal system of sponges and in locomotion of Protozoans like *Euglena*.
- Muscle is a specialised tissue of mesodermal origin.
- About 40-50 per cent of the body weight of a human adult is contributed by muscles. They have special properties like excitability, contractility, extensibility and elasticity.
- Muscles have been classified using different criteria, namely location, appearance and nature of regulation of their activities. On the basis location, three types of muscles are identified such as (i) **Skeletal** (ii) **Visceral** and (iii) **Cardiac**.
- **Skeletal muscles** are closely associated with the skeletal components of the body.
- They have a striped appearance under the microscope and hence are called **striated muscles**.
- Since their activities are under the voluntary control of the nervous system so they are known as **voluntary muscles**. They are primarily involved in locomotory actions and changes of body postures.
- **Visceral muscles** are located in the inner walls of hollow visceral organs of the body like the alimentary canal, reproductive tract, etc.
- They do not exhibit any striation and are smooth in appearance so they are called **smooth muscles (nonstriated muscle)**.
- Their activities are not under the voluntary control of the nervous system and are therefore known as **involuntary muscles**.
- They assist, for example, in the transportation of food through the digestive tract and gametes through the genital tract.
- **Cardiac muscles** are the muscles of heart. Many cardiac muscle cells assemble in a branching pattern to form a cardiac muscle.
- On the basis of appearance, cardiac muscles are **striated**.
- They are involuntary in nature as the nervous system does not control their activities directly.
- Skeletal muscle in our body is made of a number of **muscle bundles** or **fascicles** held together by a common collagenous connective tissue layer called **fascia**. **NEET** 2023
- Each muscle bundle contains a number of muscle fibres.

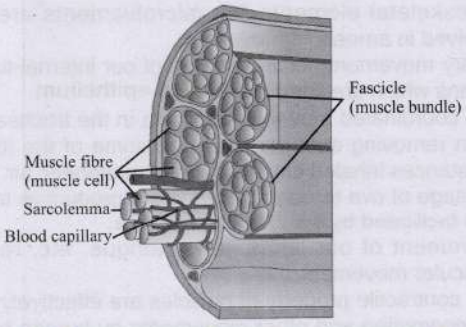



**Fig.:** Diagrammatic cross sectional view of a muscle showing muscle bundles and muscle fibres

- Each muscle fibre is lined by the plasma membrane called **sarcolemma** enclosing the sarcoplasm.
- Muscle fibre is **a syncitium** as the sarcoplasm contains many nuclei.
- The endoplasmic reticulum, i.e., sarcoplasmic reticulum of the muscle fibres is the store house of calcium ions. **NEET** 2023
- A characteristic feature of the muscle fibre is the presence of a large number of parallelly arranged filaments in the sarcoplasm called myofilaments or **myofibrils**.
- Each myofibril has alternate dark and light bands on it. The myofibril has the striated appearance is due to the distribution pattern of two important proteins – **Actin** and **Myosin**. **NEET** 2023
- The light bands contain actin and is called **I-band** or **Isotropic band**, whereas the dark band called **'A'** or **Anisotropic band** contains myosin.
- Actin and Myosin proteins are arranged as rod-like structures, parallel to each other and also to the longitudinal axis of the myofibrils.
- **Actin filaments** are thinner as compared to the myosin filaments, hence are commonly called **thin** and **thick filaments** respectively.
- In the centre of each 'I' band is an elastic fibre called **'Z' line** which bisects it.
- The thin filaments are firmly attached to the 'Z' line.
- The thick filaments in the 'A' band are also held together in the middle of this band by a thin fibrous membrane called 'M' line.
- The 'A' and 'I' bands are arranged alternately throughout the length of the myofibrils.
- The portion of the myofibril between two successive 'Z' lines is considered as the functional unit of contraction and is called a **sarcomere**.

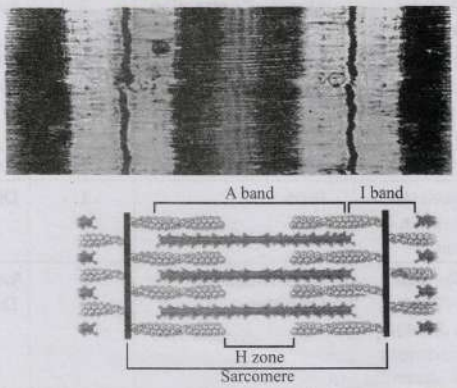



**Fig.:** Diagrammatic representation of (a) anatomy of a muscle fibre showing a sarcomere (b) a sarcomere

- In a resting state, the edges of thin filaments on either side of the thick filaments partially overlap the free ends of the thick filaments leaving the central part of the thick
- filaments. This central part of thick filament, not overlapped by thin filaments is called the **'H' zone**.

### Structure of Contractile Proteins

- Each actin (thin) filament is made of two **'F' (filamentous)** actins helically wound to each other. Each 'F' actin is a polymer of monomeric **'G' (Globular)** actins.
- Troponin is a protein which is found on actin filament and myosin protein is found in myosin filament. Both **actin and myosin are complex proteins** in striated muscles. **AIPMT** 2012

- Two filaments of another protein, **tropomyosin** also run close to the 'F' actins throughout its length.
- A complex protein Troponin is distributed at regular intervals on the tropomyosin.
- In the resting state a subunit of troponin masks the active binding sites for myosin on the actin filaments.

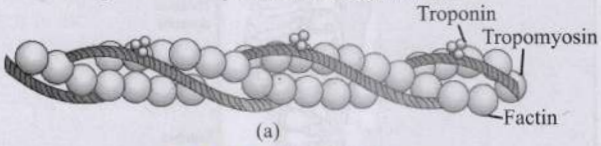



**Fig.(a):** An actin (thin) filament

- Each myosin (thick) filament is also a polymerised protein. Many monomeric proteins are **Meromyosins**. The constitute one thick filament.

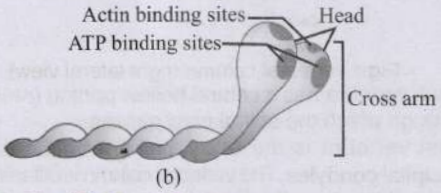



**Fig.(b):** Myosin monomer (Meromyosin)

- Each meromyosin has two important parts, a globular head with a short arm and a tail, the former being called the **heavy meromyosin (HMM)** and the latter, the **light meromyosin (LMM)**. The HMM component, i.e.; the head and short arm projects outwards at regular distance and angle from each other from the surface of a polymerised myosin filament and is known as **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

- Mechanism of muscle contraction 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.
- Muscle contraction is initiated by a signal sent by the **central nervous system (CNS)** via a motor neuron.
- A motor neuron alongwith the muscle fibres connected to it constitute a motor unit.
- The junction between a motor neuron and the sarcolemma of the muscle fibre is called the **neuromuscular junction or motor-end plate**.
- A neural signal reaching neuromuscular junction releases a neurotransmitter called as **Acetyl choline**. Acetycholine 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 **$Ca^{++}$ level** leads to the binding of calcium with a subunit of troponin on actin filaments and thereby remove the masking of active sites for myosin. **NEET** 2018
- Calcium is responsible for unmasking of active sites for cross-bridge activity during muscle contraction. **NEET** 2016
- The myosin head binds to the exposed active sites on actin to form a cross bridge utilising the energy from ATP hydrolysis.

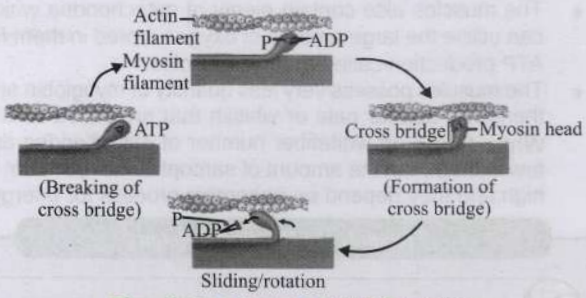



**Fig.:** Stages in cross bridge formation, rotation of head and breaking of cross bridge

- This pulls 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 shortening of the muscle, i.e., contraction, the 'I' bands get reduced, whereas the 'A' bands retain the length. **NEET** 2013 & 2021
- Sliding filament theory was given by Huxley and Huxley (1954). It states that **Actin and Myosin filaments do not become short** but rather slide pass each other. Because of sliding of actin filaments over myosin the length of I-band will change. **AIPMT** 2015

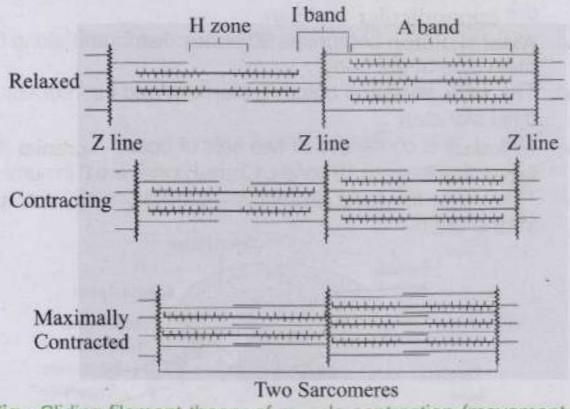



**Fig.:** Sliding-filament theory of muscle contraction (movement of the thin filaments and the relative size of the I band and H zones)

- The myosin, releasing the ADP and $P_1$ goes back to its relaxed state. A new ATP binds and the cross-bridge is broken.
- The ATP is again hydrolysed by the myosin head and the cycle of cross bridge formation and breakage is repeated causing further sliding. The process continues till the $Ca^{++}$ ions are pumped back to the sarcoplasmic cisternae resulting in the masking of actin filaments that causes the return of 'Z' lines back to their original position, i.e., relaxation.
- The reaction time of the fibres can vary in different muscles.
- Repeated activation of the muscles can lead to the accumulation of lactic acid due to anaerobic breakdown of glycogen in them, causing fatigue.
- Muscle contains a red coloured oxygen storing pigment called **myoglobin**.
- Myoglobin content is high in some of the muscles which gives a reddish appearance. That are called the **Red fibres**.

- The muscles also contain plenty of mitochondria which can utilise the large amount of oxygen stored in them for ATP production called aerobic muscles.
- The muscles possess very less quantity of myoglobin and therefore, appear pale or whitish that are called as the **White fibres**. In whitefiber number of mitochondria are few in them, but the amount of sarcoplasmic reticulum is high and they depend on anaerobic process for energy.

**To study the Human Skeleton*

## 17.3 Skeletal System

- Skeletal system consists of a framework of bones and a few cartilages. Skeletal system has a significant role in movement shown by the body. Imagine chewing food without jaw bones and walking around without the limb bones.
- Production of body heat is not a function of the skeletal system. **AIPMT** 2015
- Bone and cartilage are specialised connective tissues and the former has a very hard matrix due to calcium salts in it and the latter has slightly pliable matrix due to chondroitin salts.
- In human beings, skeletal system is made up of 206 bones and a few cartilages.
- It is grouped into two principal divisions – the axial and the **appendicular** skeleton.
- **Axial skeleton** comprises 80 bones distributed along the main axis of the body.
- The skull, vertebral column, sternum and ribs constitute axial skeleton.
- The **skull** is composed of two sets of bones – **cranial** and **facial**, that totals to 22 bones. Cranial bones are 8 in number.
- They form the hard protective outer covering, cranium for the brain.

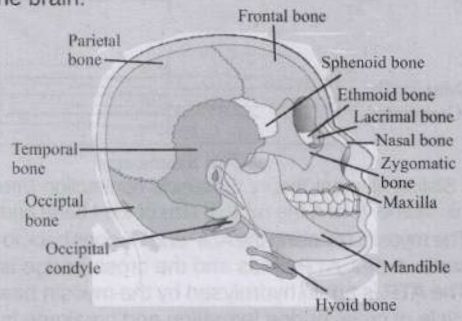



**Fig.:** Diagrammatic view of human skull

- The facial region is made up of 14 skeletal elements which form the front part of the skull.
- A single U-shaped bone called **hyoid** is present at the base of the buccal cavity and it is also included in the skull.
- Each middle ear contains three tiny bones such as **Malleus**, **Incus** and **Stapes**, collectively called **Ear Ossicles**.
- The skull region articulates with the superior region of the vertebral column with the help of two occipital condyles (dicondylic skull).
- Our **vertebral column** is formed by 26 serially arranged units called **vertebrae** and is dorsally placed. It extends from the base of the skull and constitutes the main framework of the trunk.

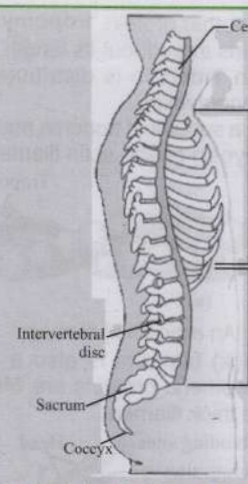



**Fig.:** Vertebral column (right lateral view)

- Each vertebra has a central hollow portion (neural canal) through which the spinal cord passes.
- First vertebra is the atlas and it articulates with the **occipital condyles**. The vertebral column is differentiated into **cervical (7), thoracic (12), lumbar (5), sacral (1-fused)** and **coccygeal (1-fused)** regions starting from the skull.
- The number of cervical vertebrae are seven in almost all mammals including human beings.
- The vertebral column protects the spinal cord, supports the head and serves as the point of attachment for the ribs and musculature of the back.
- **Sternum** is a flat bone on the ventral midline of thorax.
- There are 12 pairs of **ribs** in Human being. Each rib is a thin flat bone connected dorsally to the vertebral column and ventrally to the sternum. **NEET** 2019
- It has two articulation surfaces on its dorsal end and is hence called **bicephalic**.
- First seven pairs of ribs are called **true ribs**.
- Dorsally, they are attached to the thoracic vertebrae and ventrally connected to the sternum with the help of hyaline cartilage.
- The $8^{th}$, $9^{th}$ and $10^{th}$ pairs of ribs do not articulate directly with the sternum but join the seventh rib with the help of hyaline cartilage.
- That are called **vertebrochondral (false)** ribs. Last 2 pairs ($11^{th}$ and $12^{th}$) of ribs are not connected ventrally and are therefore, called **floating ribs**. **NEET** 2019
- Thoracic vertebrae, ribs and sternum together form the rib cage.

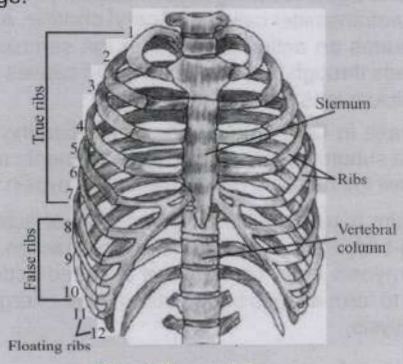



**Fig.:** Ribs and rib cage

- The bones of the limbs alongwith their girdles constitute the **appendicular skeleton**. Each **limb** is made of 30 bones.
- The bones of the hand that is fore limb are humerus, radius and **ulna**, **carpals** (wrist bones – 8 in number), **metacarpals** (palm bones – 5 in number) and **phalanges** (digits – 14 in number).


Fig.: Right pectoral girdle and upper arm. (frontal view)

- Femur (thigh bone – the longest bone), **tibia** and **fibula**, **tarsals** (ankle bones – 7 in number), **metatarsals** (5 in number) and **phalanges** (digits – 14 in number) are the bones of the legs (hind limb). A cup shaped bone called patella cover the knee ventrally (knee cap).

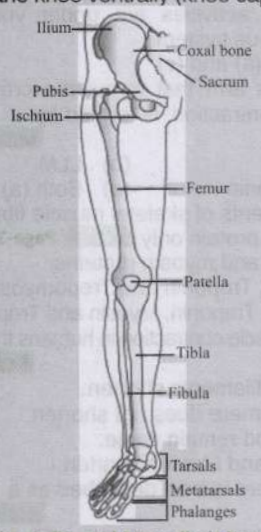



Fig.: Right pelvic girdle and lower limb bones (frontal view)

- **Pectoral** and **Pelvic girdle** bones help in the articulation of the upper and the lower limbs respectively with the axial skeleton.
- Each girdle is formed of two halves and each half of **pectoral girdle** consists of a **clavicle** and a **scapula**.
- Scapula is a large triangular flat bone situated in the dorsal part of the thorax between the second and the seventh ribs.
- The dorsal, flat, triangular body of scapula has a slightly elevated ridge called the **spine** which projects as a flat, expanded process called the **acromion**. The clavicle articulates with this.
- Below the acromion is a depression called the **glenoid cavity** which articulates with the head of the humerus to form the shoulder joint. Each clavicle is a long slender bone with two curvatures and this bone is commonly called the **collar bone**.
- Pelvic girdle consists of two coxal bones.
- Each coxal bone is formed by the fusion of three bones – **ilium**, **ischium** and **pubis**. At the point of fusion of the above bones is a cavity called acetabulum to which the thigh bone articulates.
- The two halves of the pelvic girdle meet ventrally to form the pubic symphysis containing fibrous cartilage.

## 17.4 Joints

- Joints are essential for all types of movements involving the bony parts of the body.
- Joints are points of contact between bones, or between bones and cartilages.
- Force generated by the muscles is used to carry out movement through joints, where the joint acts as a fulcrum.
- Joints have been classified into three major structural forms, namely, **fibrous**, **cartilaginous** and **synovial**.
- **Fibrous joints** do not allow any movement. **AIPMT** ⟨ 2015, **NEET** ⟨ 2024
- This type of joint is shown by the flat skull bones which fuse end-to-end with the help of dense fibrous connective tissues in the form of sutures, to form the cranium. **NEET** ⟨ 2023, 2024
- In **cartilaginous joints**, the bones involved are joined together with the help of cartilages such as the joint between the adjacent vertebrae in the vertebral column is of this pattern and it permits limited movements. **NEET** ⟨ 2023, 2024
- **Synovial joints** 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.
- **Ball** and **socket joint** (between humerus and pectoral girdle), hinge joint (knee joint), pivot joint is a type of synovial joint (between atlas and axis), gliding joint (between the carpals) and saddle joint (between carpal and metacarpal of thumb) are some examples. **NEET** ⟨ 2013, **AIPMT** ⟨ 2014 & **NEET** ⟨ 2017, 2023, 2024

## 17.5 Disorders of Muscular and Skeletal System

- **Myasthenia gravis** is an auto immune disorder that affect neuromuscular junction leading to fatigue, weakening can prevent normal swallowing and paralysis of skeletal muscle. **NEET** ⟨ 2013,2019 & 2021
- **Muscular dystrophy** is a progressive degeneration of skeletal muscle that occurs due to genetic disorder. **NEET** ⟨ 2019
- **Tetany** is a Rapid spasms (wild contractions) in muscle that occurs due to low $Ca^{++}$ in body fluid.
- **Arthritis** is an Inflammation of joints. **NEET** ⟨ 2022
- **Osteoporosis** is a age-related disorder that is characterised by decreased bone mass and increased chances of fractures. Decreased levels of estrogen is a common cause. **AIPMT** ⟨ 2012 & **NEET** ⟨ 2016,2018 & 2022
- **Gout** is an Inflammation of joints due to accumulation of uric acid crystals. **NEET** ⟨ 2013

## Tips/Tricks/Techniques ONE-Liners
(Exam Special)

- Muscle contraction was studied by Hugh Huxley and Jean Hanson.
- Isometric is a type of muscle contraction in which muscle does not shorted during contraction.
- A quick contraction that occurs due to a single stimulus is called as a twitch contraction.
- The muscle that works in opposition to other muscles is known as antagonistic muscle.
- Rigor mortis occurs due to lack of ATP.
- The disease that affects the muscles that control the voluntary movement of the body is known as Myopathy.

## Exercise 1 : NCERT Based Topic-wise MCQs

### 17.1 Types of Movement

1. Mark the incorrect statement in the followings NCERT ⟨ Page-302 / N-217
   (a) All movements lead to locomotion
   (b) Ciliary movement help in passage of ova through female reproductive tract
   (c) Microfilaments are involved in amoeboid movement
   (d) In *Paramecium* the cilia help in movement of food through cytopharynx and in locomotion as well
2. The macrophages in human body exhibit NCERT ⟨ Page-303 / N-218
   (a) ciliary movement
   (b) amoeboid movement
   (c) no movement
   (d) movement with the blood flow only
3. Microfilaments are involved in NCERT ⟨ Page-303 / N-218
   (a) amoeboid movement
   (b) ciliary movement
   (c) muscular movement
   (d) Both (a) and (b)
4. Passage of ova through female reproductive tract is facilitated by NCERT ⟨ Page-303 / N-218
   (a) ciliary movement (b) amoeboid movement
   (c) flagellar movement (d) cyclosis

### 17.2 Muscle

5. Mark the correct statement NCERT ⟨ Page-303 / N-218
   (a) All striated muscles are voluntary
   (b) Visceral muscles are faintly striated
   (c) Cardiac muscles are not striated
   (d) All non-striated muscles are involuntary
6. Which of the following statement about animal skeleton is incorrect? NCERT ⟨ Page-303,304 & 309 / N-218, 219, 224
   (a) Skeletal motions are mainly the result of smooth and cardiac muscle activity.
   (b) Muscle force are exerted against some sort of supporting structure.
   (c) Articulated joints allow motion to occur in endoskeletons and exoskeletons.
   (d) Only endoskeletons contain bone.
7. Which of the following statement is not correct? NCERT ⟨ Page-308 / N-223
   (a) Red muscle fibres are slower in contraction rate.
   (b) White muscle fibres depend mainly on anaerobic glycolysis.
   (c) White muscle fibres are rich in mitochondria.
   (d) Muscles of eyeball movement are white fibres.
8. A-band of the myofibril contains NCERT ⟨ Page-305 / N-220
   (a) only thick filaments
   (b) only thin filaments
   (c) both thick and thin filaments
   (d) no filaments
9. Actin protein occurs in which of the following two forms? NCERT ⟨ Page-306 / N-221
   (a) Polymeric F- actin and monomeric G- actin
   (b) Monomeric F- actin and polymeric G-actin
   (c) The tail and a head
   (d) F-actin and G- actin, but both are globular.
10. The functional unit of contractile system of a striated muscle is NCERT ⟨ Page-305 / N-220
    (a) Sarcomere (b) Z-band
    (c) Sarcosome (d) Myofibril
11. Striated muscles are associated with the skeletal muscles. Which of the following statement matches with it? NCERT ⟨ Page-303 / N-218
    (a) They are primarily involved in locomotory action and change of postures
    (b) Present in alimentary canal, reproductive tract
    (c) Their activities are under voluntary control of nervous system
    (d) Both (a) and (c)
12. The cross arm that forms the cross bridges during muscle contraction, is formed by NCERT ⟨ Page-303 / N-218
    (a) HMM (b) LLM
    (c) Troponin (d) Both (a) and (b)
13. Thin filaments of skeletal muscle fibres contain
    (a) Actin protein only NCERT ⟨ Page-305 & 306 / N-218, 219
    (b) Actin and myosin proteins
    (c) Actin, Troponin and Tropomyosin proteins
    (d) Actin, Troponin, Myosin and Tropomyosin proteins
14. During muscle contraction in humans the NCERT ⟨ Page-307 / N-222
    (a) actin filaments shorten.
    (b) sarcomere does not shorten.
    (c) A-band remain same.
    (d) A, H and I bands shorten.
15. A sarcomere is best described as a NCERT ⟨ Page-305 / N-220
    (a) movable structural unit within a myofibril bounded by H zones.
    (b) fixed structural unit within a myofibril bounded by Z lines.
    (c) fixed structural unit within a myofibril bounded by A bands.
    (d) movable structural unit within a myofibril bounded by Z lines.

16. Cardiac muscles are different from that of skeletal muscles as the former are NCERT Page-303 & 304 / N-218, 219
(a) striated but involuntary.
(b) non striated and involuntary.
(c) smooth or unstriated.
(d) voluntary in action.

17. Red muscle fibres are rich in NCERT Page-308 / N-223
(a) golgi bodies (b) mitochondria
(c) lysosomes (d) ribosomes

18. Which of the following is not the feature of red muscle fibres? NCERT Page-308 / N-223
(a) They have plenty of mitochondria.
(b) They have high content of myoglobin.
(c) They have high amount of sarcoplasmic reticulum.
(d) They are called aerobic muscles.

19. Which of the following statement is correct? NCERT Page-303 / N-218
(a) All striated muscles are voluntary.
(b) Visceral muscles are faintly striated.
(c) Cardiac muscles are not striated.
(d) All non-striated muscles are involuntary.

20. During muscle contraction. NCERT Page-307 / N-222
(a) chemical energy is changed to electrical energy.
(b) mechanical energy is changed to chemical energy.
(c) chemical energy is changed to physical energy.
(d) chemical energy is changed to mechanical energy.

21. According to the sliding filament theory of muscle contraction NCERT Page-307 & 308 / N-222, 223
(a) actin binds ATP and breaks it apart as actin pulls against myosin.
(b) calcium ions are released from myosin as the filaments slide by.
(c) the thick and thin filaments do not change length during this process.
(d) all of the above

22. Muscles of alimentary canal are mainly
(a) striated and myogenic NCERT Page-303 / N-218
(b) striated and neurogenic
(c) unstriated and neurogenic
(d) unstriated and myogenic

23. A-band of the myofibril contains NCERT Page-304 & 305 / N-219, 220
(a) only thick filaments
(b) only thin filaments
(c) both thick and thin filaments
(d) no filaments

24. The H-zone in the skeletal muscle fibre is due to NCERT Page-305 / N-220
(a) The central gap between myosin filaments in the A-band.
(b) The central gap between actin filaments extending through myosin filaments in the A-band.
(c) Extension of myosin filaments in the central portion of the A-band.
(d) The absence of myofibrils in the central portion of A-band.

25. During muscle contraction in humans the
(a) actin filaments shorten. NCERT Page-307 / N-222
(b) sarcomere does not shorten.
(c) A-band remain same.
(d) A, H and I bands shorten.

26. Which muscle protein acts as ATPase? NCERT Page-305 / N-220
(a) Actin (b) Troponin
(c) Myosin (d) Tropomyosin

27. What will happen if the sarcoplasmic reticulum of the muscle fibres is damaged? NCERT Page-304 & 305 / N-219, 220
(a) Binding of ATP to actin will be affected.
(b) Release of inhibition on Z discs will stop.
(c) Exposure of myosin binding sites on the actin will be affected.
(d) Transmission of action potential along the sarcolemma will increase.

28. Which of the following is the contractile protein of a muscle? NCERT Page-305 / N-220
(a) Tubulin (b) Myosin
(c) Tropomyosin (d) All of these

29. Characteristics of smooth muscle fibres are NCERT Page-303 / N-218
(a) spindle-shaped, unbranched, unstriated, uninucleate and involuntary
(b) spindle shaped, unbranched, unstriped, multinucleate and involuntary
(c) cylindrical, unbranched, unstriped, multinucleate and involuntary
(d) cylindrical, unbranched, striated, multinucleate and voluntary

30. Which one of the following pairs of chemical substances is correctly categorized? NCERT Page-306 / N-221
(a) Calcitonin and thymosin - Thyroid hormones
(b) Pepsin and prolactin - Two digestive enzymes secreted in stomach
(c) Troponin and myosin - Complex proteins in striated muscles
(d) Secretin and rhodopsin - Polypeptide hormones

31. Muscle contraction is triggered NCERT Page-307 / N-222
(a) when high levels of oxygen and sugar are released by the sarcolemma.
(b) when a surplus of ATP is released by a nerve motor unit.
(c) by release of a neurotransmitter at a synapse that directly causes actin and myosin to slide.
(d) by the nerve releasing a neurotransmitter, which triggers a flow of calcium that attaches to actin filaments and exposes the myosin binding sites.

32. Red muscle fibres are rich in NCERT Page-308 / N-223
(a) golgi bodies (b) mitochondria
(c) lysosomes (d) ribosomes

33. Which of the following structures is correctly organized from large to small? NCERT Page-303 & 304 / N-218, 219
(a) Muscle, Muscle cell, Myofibril, Sarcomeres, Filaments.
(b) Muscle, Muscle fibres, Sarcomeres, Filaments, Myofibrils.
(c) Muscle, Sarcolemma, Myofibrils, Actin filaments, Myosin filaments.
(d) Muscle cells, Myofibrils, Filaments, Sarcoplasm.

34. During resting stage the binding site of actin for myosin remains masked by NCERT Page-306 / N-221
(a) troponin (b) G-actin
(c) tropomyosin (d) meromyosin

35. Which of the following is the store house of calcium in muscles? NCERT Page-304 / N-219
(a) Sarcosome
(b) Sarcoplasmic reticulum
(c) Creatine phosphate
(d) Sarcomere

36. What is the correct order that a motor nerve impulse travels when triggering a muscle contraction? NCERT ⟨ Page-307 & 308 / N-222, 223
(a) Motor nerve → synaptic cleft → sarcolemma → sarcoplasmic reticulum → troponin.
(b) Motor nerve → synaptic cleft → sarcolemma → troponin → sarcoplasmic reticulum.
(c) Motor nerve → sarcoplasmic reticulum → synaptic cleft → sarcolemma → troponin.
(d) Motor nerve → sarcolemma → sarcoplasmic reticulum → synaptic cleft → troponin.

37. The label X in the given figure of an act in filament represents NCERT ⟨ Page-306 / N-221


(a) actin (b) myosin
(c) tropomyosin (d) troponin

38. The slow twitch muscle fibres which are rich in myoglobin and have abundant mitochondria are
(a) White skeletal muscles NCERT ⟨ Page-308 / N-223
(b) Cardiac muscles
(c) red skeletal muscles
(d) involuntary muscles.

39. The H-zone in the skeletal muscle fibre is due to : NCERT ⟨ Page-305 / N-220
(a) The central gap between myosin filaments in the A-band.
(b) The central gap between actin filaments extending through myosin filaments in the A-band
(c) Extension of myosin filaments in the central portion of the A-band.
(d) The absence of myofibrils in the central portion of A-band.

## 17.3 Skeletal System

40. Phallangeal formula of hand of man is NCERT ⟨ Page-310 / N-225
(a) 1, 2, 2, 2, 2 (b) 2, 1, 1, 1, 1
(c) 2, 3, 3, 3, 3 (d) 2, 3, 3, 2, 2

41. In mammals the lower jaw is made of NCERT ⟨ Page-309 / N-224
(a) maxilla (b) dentary
(c) mandible (d) ethmoid

42. Hyoid bone is located NCERT ⟨ Page-309 / N-224
(a) at the top of the buccal cavity.
(b) at the floor of the buccal cavity.
(c) in front of the skull.
(d) behind the skull.

43. Which one of the following pairs of structures is correctly matched with their correct description? NCERT ⟨ Page-309 & 311 / N-224, 226

| Structures | | Description |
|---|---|---|
| (a) Tibia and fibula | – | Both form parts of knee joint |
| (b) Cartilage and cornea | – | No blood supply but do require oxygen for respiratory need |
| (c) Shoulder joint | – | Ball and socket type of joint and elbow joint |
| (d) Premolars and molars | – | 20 in all and 3⁻ rooted |

44. The coxal bone consists of NCERT ⟨ Page-311 / N-226
(a) Clavicle, coracoid and scapula
(b) Maxilla, jugal and squamosal
(c) Ilium, ischium and pubis
(d) Two clavicles and one interclavicle

45. Which of the following is not part of axial skeleton? NCERT ⟨ Page-309 / N-224
(a) Sacrum (b) Sternum
(c) Mandible (d) Humerus

46. The vertebral formula of human adult is NCERT ⟨ Page-310 / N-225
(a) $C_7T_{12}L_5S_5Cd_1$ (b) $C_7T_{12}L_5S_5Cd_5$
(c) $C_7T_{12}L_5S_5Cd_4$ (d) $C_7T_{12}L_5S_4Cd_4$

47. Part of the body having a single pair of bones is called NCERT ⟨ Page-311 / N-226
(a) pelvic girdle (b) external ear
(c) wrist (d) lower jaw

48. Which of the following vertebrae are fused? NCERT ⟨ Page-310 / N-225
(a) Cervical (b) Sacral
(c) Lumber (d) Thoracic

49. Function of long bones in adult mammals is to provide
(a) support only. NCERT ⟨ Page-311 / N-226
(b) support and produce RBCs only.
(c) support and produce WBCs only.
(d) support and produce RBCs and WBCs.

50. Number of floating ribs in human body is NCERT ⟨ Page-310 / N-225
(a) two pairs (b) three pairs
(c) five pairs (d) six pairs

51. A cup shaped cavity for articulation of femur head is NCERT ⟨ Page-311 / N-226
(a) acetabulum (b) glenoid cavity
(c) sigmoid notch (d) obturator foramen

52. Which of the following is a single U shaped bone, present at the base of the buccal cavity and it is also included in the skull? NCERT ⟨ Page-309 / N-224
(a) Hyoid (b) Malleus
(c) Sacrum (d) Scapula

53. Which of the following match is incorrect? NCERT ⟨ Page-310 / N-225
(a) 8th, 9th and 10th pairs of ribs - do not articulate directly with the sternum but join the sixth rib with the help of hyaline cartilage.
(b) Glenoid cavity - articulates with the head of the humerus to form the shoulder joint.
(c) Fibrous joint - flat skull bones which fuse end-to-end with the help of dense fibrous connective tissues in the form of sutures, to form the cranium.
(d) Increase in $Ca^{++}$ level - leads to the binding of calcium with a subunit of troponin on actin filaments and thereby remove the masking of active sites for myosin.

54. A cricket player is fast chasing a ball in the field. Which one of the following groups of bones are directly contributing in this movement? NCERT ⟨ Page-311 / N-226
(a) Femur, malleus, tibia, metatarsals
(b) Pelvis, ulna, patella, tarsals
(c) Sternum, femur, tibia, fibula
(d) Tarsals, femur, metatarsals, tibia

55. Which of the following is not the function of skeleton?
(a) It allows movement. NCERT ⟨ Page-309 / N-224
(b) It supports the body.
(c) It connects muscle to joints.
(d) It protects the internal part of the body.

56. Largest and heaviest bone of human body is NCERT ⟨ Page-311 / N-226
(a) Tibia (b) Humerus
(c) Femur (d) Hip bone

57. A cup shaped cavity for articulation of femur head is NCERT ⟨ Page-311 / N-226
(a) acetabulum (b) glenoid cavity
(c) sigmoid notch (d) obturator foramen

58. Smallest bone in the human body is
NCERT Page-309 / N-224
(a) Stapes (b) Malleus
(c) Patella (d) Navicular bone

59. In man coccygeal bone is found in
NCERT Page-310 / N-225
(a) skull (b) pelvic girdle
(c) vertebral column (d) pectoral girdle

60. An acromian process is characteristically found in the:
(a) pelvic girdle of mammals NCERT Page-311 / N-226
(b) pectoral girdle of mammals
(c) skull of frog
(d) sperm of mammals

61. Total number of bones in the hind limb of man is
(a) 14 (b) 30 NCERT Page-310 / N-225
(c) 24 (d) 21

62. In human body, which one of the following is anatomically correct?
NCERT Page-310 / N-225
(a) Collar bones - 3 pairs
(b) Salivary glands - 1 pairs
(c) Cranial nerves - 10 pairs
(d) Floating ribs - 2 pairs

63. Lubrication occurs at hinge joints which need to be able to move without friction. Which one of the following substances aids lubrication? NCERT Page-312 / N-227
(a) Cartilage (b) Ligament
(c) Synovial fluid (d) Connective tissue

64. Which of the following represents the correct order of vertebral regions from superior to inferior?
NCERT Page-310 / N-225
I. Sacrum II. Thoracic
III. Cervical IV. Lumbar
V. Coccyx
(a) I – II – III – IV – V (b) II – IV – I – III – V
(c) IV – I – II – V – I (d) III – II – IV – I – V

65. In human body, which one of the following is anatomically correct? NCERT Page-310 / N-225
(a) Collar bones - 3 pairs
(b) Salivary glands - 1 pair
(c) Cranial nerves - 10 pairs
(d) Floating ribs - 2 pairs

66. The diagram given below shows the pelvic girdle and lower limb. NCERT Page-311 / N-226


Parts labelled as 'I', 'II', 'III', 'IV' and 'V' respectively indicate
(a) Ilium, Femur, Tibia, Pubis and Sacrum
(b) Pubis, Tibia, Femur, Ilium and Sacrum
(c) Ilium, Femur, Tibia, Pubis and Sacrum
(d) Pubis, Femur, Tibia, Ilium and Sacrum

67. Which one of the following is the correct description of certain part of a normal human skeleton?
NCERT Page-310 & 311 / N-225, 226
(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 9th and 10th pairs of ribs are called the floating ribs.
(d) Glenoid cavity is a depression to which the thigh bone articulates.

## 17.4 Joints

68. Shoulder joint is present between:
NCERT Page-311 / N-226
(a) Glenoid cavity of pectoral girdle & head of humerus
(b) Coronoid process of pectoral girdle & head of humerus
(c) Radius, ulna and humerus
(d) Radius and humerus

69. Elbow joint is an example of NCERT Page-312 / N-227
(a) hinge joint (b) gliding joint
(c) ball and socket joint (d) pivot joint

70. An example of gliding joint is NCERT Page-312 / N-227
(a) humerus and glenoid cavity
(b) femur and tibio-fibula
(c) occipital condyle and odontoid process
(d) zygapophyses of adjacent vertebrae

71. Identify the joint between sternum and the ribs in humans. NCERT Page-312 / N-227
(a) Fibrous joint (b) Gliding joint
(c) Cartilaginous joint (d) Angular joint

72. The joint in our neck which allows us to rotate our head left to right is NCERT Page-312 / N-227
(a) pivot joint (b) hinge joint
(c) saddle joint (d) ellipsoid joint

73. The joint between _____(i)_____ and _____(ii)_____ forms ball and socket joint. NCERT Page-312 / N-227
(a) (i) - Humerus, (ii) - Ulna
(b) (i) - Humerus, (ii) - Scapula
(c) (i) - Ulna, (ii) - Radius
(d) (i) - Ulna, (ii) - Scapula

74. Which of the following pairs of joints and its location is correctly matched? NCERT Page-312 / N-227
(a) Hinge joint – Between vertebrae
(b) Gliding joint – Between the carpals
(c) Cartilaginous joint – Skull bones
(d) Fibrous joint – Between phalanges

75. Which one of the following statements is true?
NCERT Page-311 / N-226
(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 a glenoid cavity of pelvic girdle.

76. Which of the following pair shows the correct characteristics with an example of a synovial joint in humans?
NCERT Page-312 / N-227

| | Characteristics | | Examples |
|---|---|---|---|
| (a) | Fluid filled between two joints, provides cushion | – | Skull bones |
| (b) | Fluid filled synovial cavity between two bones | – | Joint between atlas and axis |
| (c) | Lymph filled between two bones, limited movement | – | Gliding joint between carpals |
| (d) | Fluid cartilage between two bones, limited movements | – | Knee joint |

77. The type of joint in which one of the two bones fixed in its place and bears a peg like process over which the other bone rotates is called NCERT Page-312 / N-227
(a) hinge joint (b) saddle joint
(c) pivot joint (d) angular joint

78. What is the type of movable joint present between the atlas and axis? NCERT Page-312 / N-227
(a) Pivot (b) Saddle
(c) Hinge (d) Gliding

## 17.5 Disorders of Muscular and Skeletal System

79. Accumulation of uric acid crystals in the synovial joint causes NCERT Page-312 / N-227
(a) rheumatoidal arthritis
(b) gout
(c) osteoarthritis
(d) muscular dystrophy

80. Which of the following is an autoimmune disorder ? NCERT Page-312 / N-227
(a) Myasthenia gravis (b) Osteoporosis
(c) Muscular dystrophy (d) Gout

81. Select the correct statement regarding the specific disorder of muscular or skeletal system. NCERT Page-312 / N-227
(a) Myasthenia gravis – Autoimmune disorder which inhibits sliding of myosin filaments.
(b) Gout – Inflammation of joints due to extra deposition of calcium.
(c) Muscular dystrophy – Age related shortening of muscles.
(d) Osteoporosis – Decrease in bone mass and higher chances of fractures with advancing age.

82. Osteoporosis, an age-related disease of skeletal system, may occur due to NCERT Page-312 / N-227
(a) immune disorder affecting neuromuscular junction leading to fatigue.
(b) high concentration of $Ca^{2+}$ and $Na^{+}$
(c) decreased level of oestrogen.
(d) accumulation of uric acid leading to inflammation of joints.

# Exercise 2 : NCERT Exemplar & Past Years NEET

## NCERT Exemplar Questions

1. Match the following columns. NCERT Page-304 & 305 / N-219, 220

| | Column I | | Column II |
|---|---|---|---|
| A. | Fast muscle fibre | I. | Myoglobin |
| B. | Slow muscle fibres | II. | Lactic acid |
| C. | Actin filament | III. | Contractile unit |
| D. | Sarcomere | IV. | I-band |

| | (A) | (B) | (C) | (D) |
|---|---|---|---|---|
| (a) | I | II | IV | III |
| (b) | II | I | III | IV |
| (c) | II | I | IV | III |
| (d) | III | II | IV | I |

2. Ribs are attached to NCERT Page-310 / N-225
(a) scapula (b) sternum
(c) clavicle (d) ilium

3. What is the type of movable joint present between the atlas and axis? NCERT Page-312 / N-227
(a) Pivot (b) Saddle
(c) Hinge (d) Gliding

4. ATPase of the muscle is located in NCERT Page-307 / N-222
(a) actinin (b) troponin
(c) myosin (d) actin

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

6. Which one of the following is showing the correct sequential order of vertebrae in the vertebral column of human beings? NCERT Page-310 / N-225
(a) Cervical - lumbar - thoracic - sacral - coccygeal
(b) Cervical - thoracic - sacral - lumbar - coccygeal
(c) Cervical - sacral - thoracic - lumbar - coccygeal
(d) Cervical - thoracic - lumbar - sacral - coccygeal

7. Which one of the following pair is incorrect? NCERT Page-312 / N-227
(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 carpel and metacarpals of thumb

8. Knee joint and elbow joints are examples of NCERT Page-312 / N-227
(a) saddle joint (b) ball and socket joint
(c) pivot joint (d) hinge joint

9. Macrophages and leucocytes exhibit NCERT Page-303 / N-218
(a) ciliary movement
(b) flagellar movement
(c) amoeboid movement
(d) gliding movement

10. Which one of the following is not a disorder of bone? NCERT Page-312 / N-227
(a) Arthritis (b) Osteoporosis
(c) Rickets (d) Atherosclerosis

11. Which one of the following statement is incorrect? NCERT Page-303 / N-218
(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

12. Which one of the following statements is true?
NCERT Page-311 / N-226
(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 a glenoid cavity of pelvic girdle.

13. Muscles with characteristic striations and involuntary are
NCERT Page-304 / N-219
(a) muscles in the wall of alimentary canal
(b) muscles of the heart
(c) muscles assisting locomotion
(d) muscles of the eyelids

14. Match the following columns.
NCERT Page-310 & 311 / N-225, 226

| | Column I | | Column II |
|---|---|---|---|
| A. | Sternum | I. | Synovial fluid |
| B. | Glenoid cavity | II. | Vertebrae |
| C. | Freely movable joint | III. | Pectoral girdle |
| D. | Cartilagenous joint | IV. | Flat bones |

| | (A) | (B) | (C) | (D) |
|---|---|---|---|---|
| (a) | II | I | III | IV |
| (b) | IV | III | I | II |
| (c) | II | I | IV | III |
| (d) | IV | I | II | IV |

## Past Years NEET

15. Lack of relaxation between successive stimuli in sustained muscle contraction is known as 2016, C
(a) Spasm (b) Fatigue
(c) Tetanus (d) Tonus

16. Name the ion responsible for unmasking of active sites for myosin for cross-bridge activity during muscle contraction. NCERT Page-307 / N-222 | Phase-II 2016, C
(a) Sodium (b) Potassium
(c) Calcium (d) Magnesium

17. 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:
NCERT Page-310 / N-225 | 2017, C
(a) X = 12, Y = 5 True ribs are attached dorsally to vertebral column and sternum on the two ends.
(b) X = 24, Y = 7 True ribs are dorsally attached to vertebral column but are free on ventral side.
(c) X = 24, Y = 12 True ribs are dorsally attached to vertebral column but are free on ventral side.
(d) X = 12, Y = 7 True ribs are attached dorsally to vertebral column and ventrally to the sternum.

18. The pivot joint between atlas and axis is a type of
NCERT Page-312 / N-227 | 2017, C
(a) Cartilaginous joint (b) Synovial joint
(c) Saddle joint (d) Fibrous joint

19. Calcium is important in skeletal muscle contraction because it NCERT Page-307 / N-222 | 2018, C
(a) Binds to troponin to remove the masking of active sites on actin for myosin.
(b) Activates the myosin ATPase by binding to it.
(c) Prevents the formation of bonds between the myosin cross bridges and the actin filament.
(d) Detaches the myosin head from the actin filament.

20. Which of the following is not an autoimmune disease?
(a) Psoriasis 2018, C, BN
(b) Rheumatoid arthritis
(c) Vitiligo
(d) Alzheimer's disease

21. Which of the following hormones can play a significant role in osteoporosis? NCERT Page-312 / N-227 | 2018, C
(a) Aldosterone and Prolactin
(b) Progesterone and Aldosterone
(c) Parathyroid hormone and Prolactin
(d) Estrogen and Parathyroid hormone

22. Calcium is important in skeletal muscle contraction because it NCERT Page-307 / N-222 | 2018
(a) Binds to troponin to remove the masking of active sites on actin for myosin.
(b) Activates the myosin ATPase by binding to it.
(c) Prevents the formation of bonds between the myosin cross bridges and the actin filament.
(d) Detaches the myosin head from the actin filament.

23. Select the correct option:
NCERT Page-310 / N-225 | 2019, S
(a) 8th, 9th and 10th pairs of ribs articulate directly with the sternum.
(b) 11th and 12th pairs of ribs are connected to the sternum with the help of hyaline cartilage.
(c) Each rib is a flat thin bone and all the ribs are connected dorsally to the thoracic vertebrae and ventrally to the sternum.
(d) There are seven pairs of vertebrosternal, three pairs of vertebrochondral and two pairs of vertebral ribs.

24. Match the following joints with the bones involved:
NCERT Page-312 / N-227 | 2019, C

| | 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 carpals |
| (D) | Saddle joint | (iv) | Between humerus and ulna |

Select the correct option from the following :
(a) (A)-(i), (B)-(iii), (C)-(ii), (D)-(iv)
(b) (A)-(iii), (B)-(iv), (C)-(ii), (D)-(i)
(c) (A)-(iv), (B)-(i), (C)-(ii), (D)-(iii)
(d) (A)-(iv), (B)-(ii), (C)-(iii), (D)-(i)

25. Which of the following muscular disorders is inherited?
NCERT Page-312 / N-227 | 2019, S
(a) Tetany
(b) Muscular dystrophy
(c) Myasthenia gravis
(d) Botulism

26. Match the following columns and select the correct option. NCERT Page-310 & 311 / N-225, 226 | 2020, C

| 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 |

| | (A) | (B) | (C) | (D) |
|---|---|---|---|---|
| (a) | I | III | II | IV |
| (b) | III | II | IV | I |
| (c) | IV | III | I | II |
| (d) | II | IV | I | III |

27. During muscular contraction which of the following events occur? NCERT Page-307 & 308 / N-222, 223 | 2021, C
(i) 'H' zone disappears
(ii) 'A' band widens
(iii) 'I' band reduces in width
(iv) Myosine hydrolyzes ATP, releasing the ADP and Pi.
(v) Z-lines attached to actins are pulled inwards.
Choose the correct answer from the options given below:
(a) (ii), (iv), (v), (i) only (b) (i), (iii), (iv), (v) only
(c) (i), (ii), (iii), (iv) only (d) (ii), (iii), (iv), (v) only

28. Match List-I with List-II
NCERT Page-310 & 311 / N-225, 226 | 2021, C

| 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) | IV | III | II | I |
| (b) | I | III | II | IV |
| (c) | II | III | IV | I |
| (d) | IV | II | III | I |

29. Chronic auto immune disorder affecting neuro muscular junction leading to fatigue, weakening and paralysis of skeletal muscle is called as:
NCERT Page-312 / N-227 | 2021, C
(a) Gout (b) Arthritis
(c) Muscular dystrophy (d) Myasthenia gravis

30. Given below are two statements: one is labelled as **Assertion** and the other is labelled as **Reason**.
NCERT Page-312 / N-227 | 2022, S
**Assertion:** Osteoporosis is characterised by decreased bone mass and increased chances of fractures.
**Reason:** 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)

31. Which of the following is a **correct** match for disease and its symptoms? NCERT Page-312 / N-227 | 2022, C
(a) Tetany - high $Ca^{2+}$ level causing rapid spasms.
(b) Myasthenia gravis - Genetic disorder resulting in weakening and paralysis of skeletal muscle
(c) Muscular dystrophy - An auto immune disorder causing progressive degeneration of skeletal muscle
(d) Arthritis - Inflammed joints

32. Which of the following statements are correct regarding skeletal muscle? NCERT Page-303 / N-218 | 2023
(i) Muscle bundles are held together by collagenous connective tissue layer called fascicle.
(ii) Sarcoplasmic reticulum of muscle fibre is a store house of calcium ions.
(iii) Striated appearance of skeletal muscle fibre is due to distribution pattern of actin and myosin proteins.
(iv) M line is considered as functional unit of contraction called sarcomere.
Choose the most appropriate answer from the options given below:
(a) (i), (ii) and (iii) only (b) (ii) and (iii) only
(c) (i), (iii) and (iv) only (d) (iii) and (iv) only

33. Match List I with List II.
NCERT Page-311, 312 / N-226, 227 | 2023

| 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) A–III, B–I, C–II, D–IV
(b) A–II, B–IV, C–I, D–III
(c) A–I, B–IV, C–III, D–II
(d) A–II, B–IV, C–III, D–I

34. Match List I with List II : NCERT Page-N-227 | 2024

| 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) A-IV, B-II, C-III, D-I
(b) A-I, B-III, C-II, D-IV
(c) A-II, B-III, C-I, D-IV
(d) A-III, B-I, C-IV, D-II

# Exercise 3 : Matching, Statement & Assertion Reason Type

## Match the Following

1. Match column-I with column-II and select the correct option from the codes given below.

NCERT Page-305 / N-220

| | Column I | | Column II |
|---|---|---|---|
| A. | Structural and functional unit of a myofibril | I. | H-zone |
| B. | Protein of thin filament | II. | Myosin |
| C. | Protein of thick filament | III. | Sarcomere |
| D. | The central part of thick filament not overlapped by thin filament | IV. | Actin |

(a) A – I; B – II; C – III; D – IV
(b) A – I; B – III; C – II; D – IV
(c) A – I; B – IV; C – III; D – II
(d) A – III; B – IV; C – II; D – I

2. Match the Column I with Column II and choose the correct option.

NCERT Page-310 / N-225

| | Column I | | Column II |
|---|---|---|---|
| A. | Ribs are attached to the sternum ventrally and to the vertebrae dorsally. | I. | True ribs |
| B. | Ribs are attached to sternum through coastal cartilage (hyaline) of 7th rib | II. | False ribs |
| C. | Ribs are not attached to sternum | III. | Floating ribs |
| D. | Flat bone | IV. | Sternum |

(a) A – I; B – II; C – III; D – IV
(b) A – I; B – III; C – II; D – IV
(c) A – II; B – I; C – III; D – IV
(d) A – III; B – II; C – I; D – IV

3. Which of the following option shows the correctly matched bones (given in column I) with its pair (given in column II)?

NCERT Page-311 / N-226

| | Column I | | Column II |
|---|---|---|---|
| A. | Carpals | I. | Bones that form the fingers and toes |
| B. | Tarsals | II. | Bones that form wrist |
| C. | Phalanges | III. | Bones that form the palms of the hands |
| D. | Metacarpals | IV. | Bones that form the ankles |

(a) A – II; B – IV; C – I; D – III
(b) A – I; B – II; C – III; D – IV
(c) A – III; B – II; C – IV; D – I
(d) A – IV; B – I; C – III; D – II

4. Match column I (types of synovial joints) with column II (bones involved) and choose the correct option.

NCERT Page-312 / N-227

| | Column I (Type of synovial joint) | | Column II (Bone involved) |
|---|---|---|---|
| A. | Ball and Socket joint | I. | Carpal and metacarpal of thumb |
| B. | Hinge joint | II. | Humerus and pectoral girdle |
| C. | Pivot joint | III. | Knee |
| D. | Saddle joint | IV. | Atlas and axis |

(a) A – I; B – II; C – III; D – IV
(b) A – II; B – III; C – IV; D – I
(c) A – III; B – I; C – IV; D – II
(d) A – IV; B – III; C – II; D – I

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

NCERT Page-310 & 311 / N-225, 226

| | Column-I | | Column-II |
|---|---|---|---|
| (A) | Fibrous joints | I. | Located between second and seventh ribs |
| (B) | Acromion | II. | Between atlas and axis |
| (C) | Scapula | III. | Clavicle |
| (D) | Pivot joint | IV. | Do not allow any movement. |

(a) A – I; B – III; C – II; D – IV
(b) A – III; B – II; C – IV; D – I
(c) A – IV; B – III; C – I; D – II
(d) A – II; B – IV; C – I; D – III

6. Which of the following human skeletal parts are correctly matched with their respective category?

NCERT Page-310 & 311 / N-225, 226

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

(a) A and B only (b) A, B and C only
(c) A, B, and D only (d) All of the above

## Two Statement Type Questions

**DIRECTION:** *Read the statements carefully and answer the question on the basis of following options.*

(a) Both Statement I and Statement II are incorrect
(b) Statement I is correct but Statement II is incorrect
(c) Statement I is incorrect but Statement II is correct
(d) Both Statement I and Statement II are correct

7. **Statement I:** Human ribs are bicephalic as they possess two articulation surfaces.
**Statement II:** Floating ribs are not connected to sternum ventrally.

NCERT Page-310 / N-225

8. **Statement I:** Ciliary movements are observed in internal tubular organs.
**Statement II:** About 80% of the body weight of a human adult is contributed by muscles.
NCERT Page-303 / N-218

9. **Statement I:** In resting state, edges of thin filament partially overlap the ends of thick filament.
**Statement II:** H-zone is the overlapped area of thick and thin filaments. NCERT Page-305 / N-220

10. **Statement I:** Acetylcholine is released when the neural signal reaches to the motor end-plate.
**Statement II:** Muscle contraction is initiated by signals sent by CNS *via* a sensory neuron.
NCERT Page-307 / N-222

## Four/Five Statement Type Questions

11. Read the following (i to v) statements and select the one option that contains both correct statements
NCERT Page-304 & 305 / N-219, 220
(i) Z-line is present in the centre of the light band .
(ii) Thin filaments are firmly attached to the M-line
(iii) The central part of thick filaments, not overlapped by thin filaments is called Z-band
(iv) Light band contains only thin filaments
(v) Actin filaments are thicker as compared to the myosin filaments.
(a) (i) and (iv) (b) (ii), (v) and (iii)
(c) (i) and (iii) (d) (ii) and (iv)

12. Which of the following properties of cardiac muscles are correct? NCERT Page-304 / N-219
(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.
(v) Cardiac muscles not straited.
Select the correct option.
(a) (i) and (iii) (b) (ii), (iv) and (v)
(c) (i), (iv) and (v) (d) (ii) and (iii)

13. Consider the following statements.
NCERT Page-304 & 305 / N-219, 220
(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)

14. Select the incorrect statements. NCERT Page-307 / N-222
(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) an (Iv) (d) (ii) and (iv)

15. Read the following 4-statements (i – iv) and accordingly mark the option that has both correct statements.
NCERT Page-303 & 304 / N-218, 219
(i) Cardiac fibres are branched with one or more nuclei.
(ii) Smooth muscles are unbranched and cylindrical.
(iii) Striated muscles can be branched or unbranched.
(iv) Involuntary muscles are non-striated.
(a) (i) and (iv) (b) (ii) and (iii)
(c) (iii) and (iv) (d) (i) and (iii)

16. Given below are some events which occur during muscle contraction. NCERT Page-307 & 308 / N-222, 223
(i) ATP is hydrolyzed.
(ii) Myosin heads bind to actin.
(iii) Hemoglobin concentration in muscle fibers increases.
(iv) Calcium concentration in the sarcomere increase.
(v) I bands shorten and H zones disappear.
Select the correct events which occur during muscle contraction.
(a) (i) only
(b) (ii), (iii) & (iv) only
(c) (i), (ii), (iv) & (v) only
(d) All of these.

## Assertion & Reason Questions

**DIRECTIONS:** *These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following four responses.*
(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)

17. **Assertion:** Ball and socket joints are the most mobile joints.
**Reason:** Synovial fluid is present here.
NCERT Page-312 / N-227

18. **Assertion:** Arthritis or inflammation of a joint makes the joint painful.
**Reason:** Some toxic substances are deposited at the joint. NCERT Page-312 / N-227

19. **Assertion:** The phase of muscle contraction occurs when myosin binds and releases actin.
**Reason:** Muscle contraction is initiated by a signal sent by the peripheral nervous system via motor neuron. NCERT Page-307 / N-222

20. **Assertion:** Inflammation of a skeletal joint may immobilise the movements of the joint.
**Reason:** Uric acid crystals in the joint cavity and ossification of articular cartilage lead to this.
NCERT Page-312 / N-227

21. **Assertion:** There are similarities between the locomotion of unicellular organisms and multicellular animals.
**Reason:** Ciliary, flagellar and amoeboid movements occur in unicellular organisms. NCERT Page-302 / N-217

## Exercise 4 : Skill Enhancer MCQs

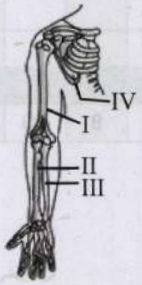
1. Which of the following represents the correct order of vertebral regions from superior to inferior?
   (i) Sacrum (ii) Thoracic
   (iii) Cervical (iv) Lumbar
   (v) Coccyx
   (a) (i), (ii), (iii), (iv), (v) (b) (ii), (iv), (i), (iii), (v)
   (c) (iv), (i), (ii), (v), (i) (d) (iii), (ii), (iv), (i), (v)

2. There are three blanks in the following statement. Mark the correct option having suitable words for filling the blanks.
   The thin filaments of myofibril contain ..... 'A'.....actin and two filaments of ..... 'B'.....protein along with ..... 'C'.....protein for masking binding site for myosin.

| | 'A' | 'B' | 'C' |
|---|---|---|---|
| (a) | 1F | troponin | tropomyosin |
| (b) | 1F | tropomyosin | troponin |
| (c) | 2F | troponin | tropomyosin |
| (d) | 2F | tropomyosin | troponin |

3. A student was given sample of two muscles marked as 1 and 2. When he compared the muscles he found that muscle 1 contains large amount of myoglobin and utilize large amount of stored oxygen for ATP production whereas muscle 2 contains few myoglobin, mitochondria and high sarcoplasmic reticulum.
   Identify the correct conclusion regarding the muscle 1 and 2 from the option given below.
   (a) Both the muscles are called aerobic muscles.
   (b) Both the muscles are called red fibers and depend on aerobic process for energy.
   (c) Muscle 1 is called white fibers and whereas muscle 2 depends on aerobic process for energy.
   (d) Muscle 1 is called red fibers and aerobic muscles whereas muscle 2 is called white fibers and depend on anaerobic process for energy.

4. The given diagram represents the bones of human arm. Identify the bones marked as I, II, III & IV.



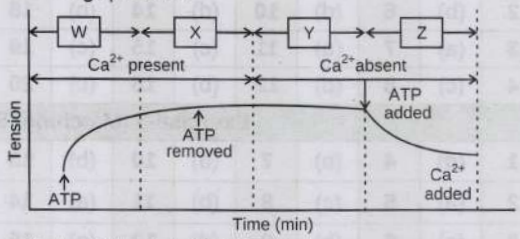

| | I | II | III | IV |
|---|---|---|---|---|
| (a) | Clavicle | Ulna | Radius | Humerus |
| (b) | Humerus | Radius | Ulna | Scapula |
| (c) | Scapula | Radius | Ulna | Clavicle |
| (d) | Humerus | Ulna | Radius | Scapula |

5. Consider the following statements with two blanks X and Y and select the option which correctly fills up these blanks?
   In the centre of the inter vertebral disc, a soft area is present called .....X..... .
   Which is supposed to be remnant of .....Y..... .

| | X | Y |
|---|---|---|
| (a) | Nucleus pulposus | Nerve cord |
| (b) | Centrum | Notecord |
| (c) | Nucleus pulposus | Notecord |
| (d) | Centrum | Nerve cord |

6. Consider the following statements each with one or two blanks.
   (i) Each pectoral girdle consists of a _____ (A)_____ and ___(B)_____
   (ii) _____(C)_____ is a condition of rapid spasms (wild contractions) in muscle due to low $Ca^{++}$ in body fluid.
   (iii) Each organised skeletal muscle in our body is made of a number of (D) held together by a common collagenous connective tissue layer called _____(E)_____.
   Which one of the following options correctly fills the blanks in any two of statements?
   (a) (C) - Muscular dystrophy, (D)- fascia, (E)- fascicle
   (b) (A)- Clavicle, (B)- scapula, (C)- Tetany
   (c) (A)- ilium, (B) -ischium, (D)- fascicles, (E) - fascia
   (d) (C) - Myasthenia gravis, (D)- fascicles, (E)- fascia.

7. Refer to the given graph carefully and answer the following question.




   Which of the labelled parts on the graph represents rigor mortis?
   (a) X (b) W
   (c) Z (d) Y

8. "X" is a large triangular flat bone situated in the dorsal part of the thorax between the "Y" and the seventh ribs. Identify "X" and "Y".
   (a) X - Patella ; Y - Third
   (b) X - Clavicle ; Y - Eight
   (c) X - Scapula ; Y - Sixth
   (d) X - Scapula ; Y - Second

9. Which of the following statements about the molecular arrangement of actin and myosin myofibrils is incorrect?
   (i) Each actin (thin filament) is made of 2F (filamentous) actins.

(ii) F-actin is the polymer of G (glubular) actin.
(iii) 2F-actins are twisted into a helix.
(iv) Two strands of tropomyosin (protein) lie in the grooves of F-actin.
(a) (i), (iii), (v) (b) (ii), (iv) and (v)
(c) Only (v) (d) Only (iii)

10. Which of the following statements is/are correct?
(i) The cilia and flagella are the outgrowths of the cell membrane.
(ii) Muscle is a specialised tissue of mesodermal origin.
(iii) **Skeletal muscles** are closely associated with the skeletal components of the body.
(iv) **Cardiac muscles** are the muscles of heart. Many cardiac muscle cells assemble in a branching pattern to form a cardiac muscle.
(v) On the basis of appearance, cardiac muscles are **striated**.
(a) Only (i) and (v)
(b) Only (i), (ii) and (iv)
(c) Only (i), (ii), (iv) and (v)
(d) All of them

## Answer Keys

| Exercise-1 (NCERT Based Topic-wise MCQs) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | (a) | 10 | (a) | 19 | (d) | 28 | (b) | 37 | (d) | 46 | (c) | 55 | (c) | 64 | (d) | 73 | (b) | 82 | (c) |
| 2 | (b) | 11 | (d) | 20 | (d) | 29 | (a) | 38 | (c) | 47 | (a) | 56 | (c) | 65 | (d) | 74 | (b) | | |
| 3 | (a) | 12 | (a) | 21 | (c) | 30 | (c) | 39 | (b) | 48 | (b) | 57 | (a) | 66 | (d) | 75 | (b) | | |
| 4 | (a) | 13 | (c) | 22 | (d) | 31 | (d) | 40 | (c) | 49 | (a) | 58 | (a) | 67 | (a) | 76 | (b) | | |
| 5 | (d) | 14 | (c) | 23 | (a) | 32 | (b) | 41 | (c) | 50 | (a) | 59 | (c) | 68 | (a) | 77 | (c) | | |
| 6 | (a) | 15 | (d) | 24 | (b) | 33 | (a) | 42 | (b) | 51 | (a) | 60 | (b) | 69 | (a) | 78 | (a) | | |
| 7 | (c) | 16 | (a) | 25 | (c) | 34 | (a) | 43 | (b) | 52 | (a) | 61 | (b) | 70 | (d) | 79 | (b) | | |
| 8 | (c) | 17 | (b) | 26 | (c) | 35 | (b) | 44 | (c) | 53 | (a) | 62 | (d) | 71 | (c) | 80 | (a) | | |
| 9 | (a) | 18 | (c) | 27 | (c) | 36 | (a) | 45 | (d) | 54 | (d) | 63 | (c) | 72 | (a) | 81 | (d) | | |
| **Exercise-2 (NCERT Exemplar & Past Years NEET)** | | | | | | | | | | | | | | | | | | | |
| 1 | (c) | 5 | (c) | 9 | (c) | 13 | (b) | 17 | (d) | 21 | (d) | 25 | (b) | 29 | (d) | 33 | (b) | | |
| 2 | (b) | 6 | (d) | 10 | (d) | 14 | (b) | 18 | (b) | 22 | (a) | 26 | (c) | 30 | (b) | 34 | (d) | | |
| 3 | (a) | 7 | (a) | 11 | (c) | 15 | (c) | 19 | (a) | 23 | (d) | 27 | (b) | 31 | (d) | | | | |
| 4 | (c) | 8 | (d) | 12 | (b) | 16 | (c) | 20 | (d) | 24 | (b) | 28 | (a) | 32 | (b) | | | | |
| **Exercise-3 (Matching, Statement & Assertion Reason Type)** | | | | | | | | | | | | | | | | | | | |
| 1 | (d) | 4 | (b) | 7 | (d) | 10 | (b) | 13 | (a) | 16 | (c) | 19 | (b) | | | | | | |
| 2 | (a) | 5 | (c) | 8 | (b) | 11 | (a) | 14 | (d) | 17 | (a) | 20 | (d) | | | | | | |
| 3 | (a) | 6 | (b) | 9 | (d) | 12 | (a) | 15 | (d) | 18 | (b) | 21 | (a) | | | | | | |
| **Exercise-4 (Skill Enhancer MCQs)** | | | | | | | | | | | | | | | | | | | |
| 1 | (d) | 2 | (d) | 3 | (d) | 4 | (b) | 5 | (c) | 6 | (b) | 7 | (d) | 8 | (d) | 9 | (c) | 10 | (d) |

# 17 Locomotion and Movement

## EXERCISE - 1

1. **(a)** The property of moving from one place to another is known as locomotion. Locomotion is a type of movement but all movements are not locomotion.
2. **(b)** Movement of leucocyte, **macrophages** and cytoskeletal elements in our body exhibits amoeboid movement. It is a type of movement which occur with the help of pseudopodia formed by cytoplasmic streaming (as in *Amoeba*).
3. **(a)**
4. **(a)** Passage of ova through female reproductive tract is facilitated by ciliary movement.
5. **(d)** All non-striated muscles are involuntary.
6. **(a)** Skeletal muscle is usually what makes skeletons move, not cardiac or smooth muscle.
7. **(c)** White muscle fibres are poorer in mitochondria.
8. **(c)** A - band of myofibrils contains both thick and thin filaments. A myofibril (also known as a muscle fibril) is a basic rod-like unit of a muscle. Myofibrils are composed of long proteins such as actin, myosin, and titin, and other proteins that hold them together. These proteins are organized into thin filaments and thick filaments, which repeat along the length of the myofibril in sections called sarcomeres. Muscles contract by sliding the thin (**actin**) and thick (**myosin**) filaments along each other.
9. **(a)** Actin is a protein that functions in the contractile system of skeletal muscle, where it is found in the thin filaments. Actin protein occurs in two forms - polymeric F actin and monomeric G actin. In muscles, fibrous actin (F-actin) is a helical polymer of a globular polypeptide chain, G-actin.
10. **(a)** The functional unit of contractile system of a straited muscle is sarcomere.
11. **(d)** Statement (a) and (c) are correct so option (d) is correct option.
12. **(a)** The cross arm that forms the cross bridges during muscle contraction, is formed by HMM.
13. **(c)** Thin filaments of skeletal muscle fibres contain actin, troponin and tropomyosin proteins.
14. **(c)** Increase in $Ca^{++}$ level into the sarcoplasm leads to the binding of calcium with a subunit of troponin on actin filaments and there by remove the masking of active sites for myosin. Utilizing 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. The 'Z' line attached to these actins are also pulled inwards thereby causing a shortening of the sarcomere, i.e., contraction. It is clear from the above steps, that during shortening of the muscle, *i.e.*, contraction, the 'I' bands get reduced, whereas the 'A' bands retain the length.
15. **(d)** A **sarcomere** is a structural unit within a myofibril bounded by Z lines that contain actin and myosin.
16. **(a)** Cardiac muscle fibres are striated but involuntary in action while skeletal muscle fibres are striated but voluntary in action.
17. **(b)** A red muscles fibre is a muscle in which small dark fibers predominate and myoglobin and mitochondria are abundant. Red muscle fibres contract and fatigue more slowly than white fibres and generate ATP by aerobic catabolism of glucose and fats, utilizing myoglobin-bound $O_2$.
18. **(c)** Red muscle fibres are one of the two main types of skeletal muscle, which contains abundant mitochondria and myoglobin. Red muscle fibres contract and fatigue more slowly than white fibres and generate ATP by aerobic catabolism of glucose and fats, utilizing myoglobin-bound $O_2$.
    Sarcoplasmic reticulum is a system of membrane-bound tubules that surrounds muscle fibrils, releasing calcium ions during contraction and absorbing them during relaxation.
19. **(d)** **Smooth muscles** are non-striated. Their activities are not under control of the nervous system and are therefore known as involuntary muscles. All striated muscles are not voluntary. Visceral muscles are located in hollow organs. They do not exhibit any striation and are smooth in appearance. Cardiac muscles are the muscles of heart. These muscles are striated and involuntary in nature.
20. **(d)** During muscle contraction, chemical energy is changed into mechanical energy.
21. **(c)** The thick and thin filaments do not change length during muscle contraction.
22. **(d)** Muscles of alimentary canal are smooth unstriated and are innervated by fibres of ANS. These muscles are myogenic.
23. **(a)** A - band of myofibrils contains only thick filaments. A myofibril (also known as a muscle fibril) is a basic rod-like unit of a muscle. Myofibrils are composed of long proteins such as actin, myosin, and titin, and other proteins that hold them together. These proteins are organized into thin filaments and thick filaments, which repeat along the length of the myofibril in sections called sarcomeres. Muscles contract by sliding the thin (actin) and thick (myosin) filaments along each other.
24. **(b)** Central part of thick filament, not overlapped by thin filaments is called the 'H' zone. 'H' zone is also called **Hensen's Line**.

25. **(c)** Increase in $Ca^{++}$ level into the sarcoplasm leads to the binding of calcium with a subunit of troponin on actin filaments and there by remove the masking of active sites for myosin. Utilizing 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. The 'Z' line attached to these actins are also pulled inwards thereby causing a shortening of the sarcomere, *i.e.*, contraction. It is clear from the above steps, that during shortening of the muscle, *i.e.*, contraction, the 'I' bands get reduced, whereas the 'A' bands retain the length.

26. **(c)**

27. **(c)** If the sarcoplasmic reticulum of the muscle fibres is damaged, the exposure of myosin binding sites on the actin will be affected.

28. **(b)**

29. **(a)** Characteristics of smooth muscle fibres.
- cells range from 5 to 10 µm in diameter and 30 to 200 µm in length
- spindle-shaped
- single, centrally located nucleus
- smooth muscle tissue occuring within almost every organ, forming sheets, bundles or sheaths around other tissues.

Smooth muscle differs from both skeletal and cardiac muscle tissues in structure and function. Sarcomeres or myofibrils are not present - therefore not striated, ie. smooth.

30. **(c)** Troponin is a protein which is found on actin filament and myosin protein is found in myosin filament. Both actin and myosin are complex proteins in striated muscles.
**Thymosin** is a hormone secreted by the thymus that stimulates development of T cells. Prolactin is a hormone released by the pituitary gland that stimulates breast development and milk production in women. Rhodopsin, also known as visual purple, is not a hormone. It is a biological pigment in photoreceptor cells of the retina that is responsible for the first events in the perception of light.

31. **(d)** Muscle contraction is triggered by a nerve releasing a neurotransmitter, which in turn triggers the sarcoplasmic reticulum to release calcium ions into the muscle interior where they bind to troponin, thus causing tropomyosin to shift from the face of the actin filament to which myosin heads need to bind to produce contraction.

32. **(b)** A red muscles fibre is a muscle in which small dark fibers predominate and myoglobin and mitochondria are abundant. Red muscle fibres contract and fatigue more slowly than white fibres and generate ATP by aerobic catabolism of glucose and fats, utilising myoglobin-bound $O_2$.

33. **(a)** The correct organization of the structures from large to small is: muscle, muscle cells, myofibrils, sarcomeres, filaments.
Muscle is a band or bundle of fibrous tissue that has the ability to contract, producing movement in or maintaining the position of parts of the body. Muscle cell is an elongated contractile cell that forms the muscles of the body. Myofibril is any of the elongated contractile threads found in striated muscle cells. Sarcomere is a structural unit of a myofibril in striated muscle, consisting of a dark band and the nearer half of each adjacent pale band. A filament is a slender thread-like object or fibre, especially one found in animal or plant structures.

34. **(a)** Troponin (having 3 subunits) is seen at regular intervals on tropomyosin. In the resting state a subunit of troponin masks the binding sites for myosin on the actin filaments.

35. **(b)** The sarcoplasmic reticulum tubules contain calcium ions which are released from the tubules on stimulation by the impulse passing along the T tubular network.

36. **(a)** The correct order that a motor nerve impulse travels when triggering a muscle contraction is: motor nerve → synaptic cleft → sarcolemma → sarcoplasmic reticulum → troponin.

37. **(d)** The label 'X' in the figure of actin filament is troponin. Troponin is a complex of three regulatory proteins (troponin C, troponin I, and troponin T) that is integral to muscle contraction in skeletal muscle and cardiac muscle, but not smooth muscle. Troponin is attached to the protein tropomyosin and lies within the groove between actin filaments in muscle tissue. In a relaxed muscle, tropomyosin blocks the attachment site for the myosin cross bridge, thus preventing contraction.

38. **(c)** Muscles contain a red coloured pigment called myoglobin that stores oxygen and some muscles contain high levels of myoglobin. Due to the presence of myoglobin such muscles appear reddish in colour and hence are called **red muscles**. Slow twitch muscle fibres have abundant mitochondria and show slow rate of contraction for long period and because of this they are called slow twitch muscles.

39. **(b)** Central part of thick filament, not overlapped by thin filaments is called the **'H' zone**. 'H' zone is also called Hensen's Line.

40. **(c)** 1 humerus, 1 radius, 1 ulna, 8 carpal bones 5 metacarpal bones, 5 digits (14 phalanges) phalangeal formula : 2, 3, 3, 3, 3

41. **(c)** Mandible (also known as lower jaw) is the largest, strongest and only movable bone of the face.

42. **(b)** Hyoid bone is a U-shaped bone seen below buccal cavity. It lies at the base of the mandible (approximately $C_3$), where it acts as a site of attachment for the anterior neck muscles.

43. **(b)** Cartilage and cornea – No blood supply but do require oxygen for respiratory need

44. **(c)** The coxal bone consists of ilium, ischium and pubis.

45. **(d)** Humerus is not a part of axial skeletal. It is a part of appendicular skeletal. Humerus is the bone of the upper arm or forelimb, forming joints at the shoulder and the elbow.

**46.** **(c)** The vertebral column, also known as the backbone or spine, is a bony skeletal structure found in vertebrates. It is formed from individual bones called vertebrae which house the spinal canal, a cavity that encloses and protects the spinal cord. Vertebral formula indicates the number of vertebrae in each segment of the spinal column; for humans it is $C_7$, $T_{12}$, $L_5$, $S_5$, $Cd_4$ = 33. The letters C, T, L, S, and Cd denotes cervical, thoracic, lumbar, sacral, and coccygeal.

**47.** **(a)** Part of the body having a single pair of bones is pelvic girdle. Pelvic girdle, also called bony pelvis, is a ring-like structure, located in the lower part of the trunk. It connects the axial skeleton to the lower limbs. The bony pelvis consists of the two hip bones (also known as innominate or pelvic bones), sacrum and coccyx.

**48.** **(b)** The five sacral vertebrae are fused in the adult, forming one structure called the sacrum. It lies between the innominate bones of the pelvic girdle.

**49.** **(a)** Long bones, like humerus, radius and ulna of forearm, femur, tibia and fibula of shank in adult mammals provides support.

**50.** **(a)** The number of floating ribs in human body is two pairs. They are not connected to either the sternum of the cartilage of another rib. Their main function is to protect the kidneys.

**51.** **(a)** At the point of fusion of ilium, ischium and pubis, there is a cavity called acetabulum to which the thigh bone articulates.

**52.** **(a)** **Hyoid** is a horseshoe-shaped (or U shaped) bone situated in the anterior midline of the neck between the chin and the thyroid cartilage. At rest, it lies at the level of the base of the mandible in the front and the third cervical vertebra ($C_3$) behind. The hyoid bone provides attachment to the muscles of the floor of the mouth and the tongue above, the larynx below, and the epiglottis and pharynx behind. The hyoid bone helps in tongue movement and swallowing.

**53.** **(a)** $8^{th}$, $9^{th}$ and $10^{th}$ pairs of ribs do not articulate directly with the sternum but join the seventh rib with the help of hyaline cartilage.

**54.** **(d)** **Tarsals**, femur, **metatarsal** and tibia are directly contributing the movement when a cricket player is chasing a ball in the field.

**55.** **(c)** Skeleton is the body part that forms the supporting structure of an organism. Connecting muscles to joint is not a function of skeleton. It is a function of tendon which is a flexible but inelastic cord of strong fibrous collagen tissue which attaches muscle to a bone.

**56.** **(c)**

**57.** **(a)** At the point of fusion of ilium, ischium and pubis, there is a cavity called acetabulum to which the thigh bone articulates.

**58.** **(a)** Smallest bone in the human body is stapes.

**59.** **(c)** In man coccygeal bone is found in vertebral column.

**60.** **(b)** Each half of pectoral girdle has two bones i.e. clavicle and scapula. A spine like, acromian process is attached to scapula for articulation with clavicle bone.

**61.** **(b)** Each hind limb contain 30 bones namely 1 femur in the thigh, 1 petala in the knee, 1 tibia and 1 fibula in the lower leg, 7 tarsals in the ankle, 5 metatarsals in the sole and 14 phalanges in toes.

**62.** **(d)** In human cranial nerves; 12 pairs
Floating ribs : 2 pair
Collar bones : 1 pair
Salivary gland : 3 pair

**63.** **(c)** Synovial fluid is a transparent viscid lubricating fluid secreted by a membrane of an articulation, bursa, or tendon sheath. Synovial fluid is necessary for normal joint function.

**64.** **(d)** Vertebral column is a sting like vertebrae which lies in the middorsal line of the neck and trunk. The correct order of vertebral region from superior to inferior are Cervical-thoracic-lumbar-sacrum-coccyx.

**65.** **(d)** Ribs are 12 pairs of bony bars which form the sides of chest cage. Ribs are of three type's true ribs, false ribs and floating ribs. Anatomically floating ribs are of 2 pairs (11th and 12th). These ribs are imperfectly formed and do not reach the sternum. They protect the kidney. Collar bones (Clavicle) - 2 pairs. Salivary glands - 3 pairs. Cranial nerves - 12 pairs

**66.** **(d)** The label I, II, III, IV and V respectively are pubis, femur, tibia, ilium and sacrum.

**67.** **(a)** Parietal bones and the temporal bones are present in skull. They are joined together by **fibrous joint**. Last 2 pair of ribs ($11^{th}$ and $12^{th}$) are not connected ventrally hence they are called floating ribs. Glenoid cavity is present in pectoral girdle below the acromion process. It articulates with the head of the humerus to form the shoulder joint.

**68.** **(a)** Shoulder joint is present between glenoid cavity of pectoral girdle & head of humerus.

**69.** **(a)** Elbow joint is an example of **hinge joint**. The elbow is a hinge joint; it can open and close like a door. Hinge joint is a form of diarthrosis (freely movable joint) that allows angular movement in one plane only, increasing or decreasing the angle between the bones e.g. elbow joint, knee joint etc.

**70.** **(d)** Gliding joint permit only back and forth and side to side movements. *e.g.* zygapophysis of adjacent vertebrae.

**71.** **(c)** **Cartilaginous joints** are connected entirely by cartilage (fibrocartilage or hyaline). These joints allow more movement between bones than a fibrous joint but less than the highly mobile synovial joint. Cartilaginous joint is found in between the sternum and the ribs in human. They also form the growth regions of immature long bones and the intervertebral discs of the spinal column.

**72.** **(a)** Pivot joint is a type of joint where one bone rotates around another. Example includes the joint in our neck, which allows us to rotate our head left to right.

**73.** **(b)** The joint between shoulder (scapula) and the upper arm (humerus) forms the ball and socket joint.

**74.** **(b)** Gliding joint is found between of the carpals. In gliding joint articular ends of two bones are either flat or slightly curved to allow sliding or gliding movement. Examples bones of palms and sole, between pre-zygapophyses and post-zygapophyses of vertebrae.

75. **(b)** Skull, vertebral column, ribs and sternum constitute the axial skeleton. Limb, bones and girdles form the appendicular skeleton.
Head of humerus bone articulates with the glenoid cavity of pectoral girdle. This articulation results in the formation of ball and socket joints, e.g., ball and socket joints present in shoulder.

76. **(b)** Synovial joints are characterized by the presence of a fluid filled synovial cavity between the articulating surfaces of the two bones. Such an arrangement allows considerable movement. These joints help in locomotion and many other movements. Ball and socket joint (between humerus and pectoral girdle), hinge joint (knee joint), pivot joint (between atlas and axis), gliding joint (between the carpals) and saddle joint (between carpal and metacarpal of thumb) are some examples.

77. **(c)** Pivot joint allows only a rotator movement of one bone on the other which remains stationary. A rounded end of one bone fits into a shallow pit of another bone for example joint between atlas and axis vertebrae which enables the heads to turn from side to side.

78. **(a)** **Pivot joint** is the joint found between the atlas and axis between the radius and ulna just below the elbow. This joint allows movement in only one plane. In a pivot joint, a rounded or pointed bone fits into a shallow depression of another bone.
**Saddle joint** provides free movement in two planes back-forth and side to side. The projection of one bone fits in a saddle-shaped depression of another bone. The joint between the carpel and the metacarpel of thumb in the hand is an example of saddle joint.
**Hinge joint** allows movement primarily in one plane. In a hinge joint a reel like surface of one bone fits into the concave surface of another bone for example elbow, knee, ankle, etc.
**Gliding joint** also known as plane joint, it is a common type of synovial joint formed between bones that meet at flat or nearly flat articulating surface. Examples of gliding joint include carpel bones of the wrist and joint between the carpel and metacarpel of the palm.

79. **(b)** ***Gout*** is the accumulation of uric acid crystals in the region of joints which results in painfull movements.

80. **(a)** ***Myasthenia gravis*** is a chronic autoimmune disorder. It affects neuromuscular junction leading to fatigue, weakening and paralysis of skeletal muscles.

81. **(d)** (a) Myasthenia gravis is either an autoimmune or congenital neuromuscular disease that leads to fluctuating muscle weakness and fatigue.
(b) Gout is usually characterized by recurrent attacks of acute inflammatory arthritis-a red, tender, hot, swollen joint. It is caused by elevated levels of uric acid in the blood. The uric acid crystallizes, and the crystals deposit in joints, tendons, and surrounding tissues.
(c) Muscular dystrophy is a rogressive degeneration of skeletal muscles mostly due to genetic disorder.

82. **(c)** Osteoporosis is reduction in bone mineral density, resulting in bones that are brittle and liable to fracture. Infection, injury, and synovitis can cause localised osteoporosis of adjacent bone. Generalised osteoporosis is common in the elderly, and in women after menopause. After menopause the oestrogen levels in blood plasma are much reduced. Oestrogen helps to regulate bone cells called osteoclasts which are responsible for building new bone. When oestrogen levels drop fewer osteoclasts are produced resulting in osteoporosis.

## EXERCISE - 2

### NCERT Exemplar Questions

1. **(c)** **Fast muscle fibres** contract spontaneously and reach anaerobic conditions in shorter time, so as to accumulate lactic acid in the muscles in shorter time.
**Slow muscle fibres** have a better ability to endure, as they are resistant to fatigue and contract slowly, due to accumulation of a large amount of myoglobin in them.
**Actin filaments** form the isometric band in the muscle fibre because it is the only actin protein which is present in that region.
**Sarcomere** is the contractile unit of the skeletal muscle.

2. **(b)** **Sternum :** is a flat bone present just beneath the skin in the middle of the chest. It is about 15 cm long. It consists of three parts, **manubrium** (the upper most part), **body** (the middle portion) and **xiphoid process** at the tip of the bone.
The true ribs (7 pairs) are attached to the **sternum**. The, **scapula** and clavicle together combine to form pectoral girdle, and **Ilium** is a part of the **pelvic girdle**.

3. **(a)** **Pivot joint** is the joint found between the atlas and axis between the radius and ulna just below the elbow. This joint allows movement in only one plane. In a pivot joint, a rounded or pointed bone fits into a shallow depression of another bone.
**Saddle joint** provides free movement in two planes back-forth and side to side. The projection of one bone fits in a saddle-shaped depression of another bone. The joint between the carpel and the metacarpel of thumb in the hand is an example of saddle joint.
**Hinge joint** allows movement primarily in one plane. In a hinge joint a reel like surface of one bone fits into the concave surface of another bone for example elbow, knee, ankle, etc.
**Gliding joint** also known as plane joint, it is a common type of synovial joint formed between bones that meet at flat or nearly flat articulating surface. Examples of gliding joint include carpel bones of the wrist and joint between the carpel and metacarpel of the palm.

4. **(c)** The globular head of **myosin** in muscle is an active ATPase enzyme having binding sites for ATP and active site for actin.

5. **(c)** **Intervertebral disc** is found in the vertebral column of **mammals**. These discs are present between the bodies of adjacent vertebrae from second cervical vertebra to the sacrum. Each disc consists of an outer fibrous ring made at fibrocartilage and an inner soft pulpy, highly elastic substance.
These discs are majorly involved in formation of strong joints that permit various movements of the **vertebral column** and absorb **vertical shocks**.
Intervertebral disc is not found in the vertebral column of birds reptiles or amphibians.

6. **(d)** The correct sequence showing the vertebral column of human being is as follows.
Cervical—thoracic—lumbar — sacrals —coccygeal

7. **(a)** The joint present between the humerus and the pectoral girdle is ball and socket joint. Hinge joint is present between atlas and axis and not between humerus and pectoral girdle. The examples of hinge joints are the elbow, knee, ankle and interphalangeal joint.

8. **(d)** Knee joint and elbow joints are examples of **hinge joints**.

9. **(c)** Certain specialised cells in blood like macrophages and leucocytes exhibit amoeboid movement. They have the ability to reach the interstitial fluid by squeezing through the thin walls of blood vessels, while ciliary movement, flagellar movement or gliding movement are not shown by macrophages and leucocytes.

10. **(d)** Atherosclerosis **(arteriosclerotic vascular disease)** is a condition where arteries wall get thickened as a result of invasion and accumulation of WBCs, containing both living active WBCs and remnants of dead WBC's along with **cholesterol** and **triglycerides** arthritis, osteoporosis and rickets are bone disorders.

11. **(c)** Smooth muscles are '**involuntary**' and **non-striated muscles** as their movement cannot be controlled directly like that of skeletal muscles. The inner walls of alimentary canal are non-striated and involuntary muscles.

12. **(b)** Skull, vertebral column, ribs and sternum constitute the axial skeleton. Limb, bones and girdles form the appendicular skeleton.
Head of humerus bone articulates with the glenoid cavity of pectoral girdle. This articulation results in the formation of ball and socket joints, e.g., ball and socket joints present in shoulder.

13. **(b)** Cardiac muscle fibres are supplied with both **central** and **autonomic nervous system** and are not under the control of the will of the **animal**, *i.e.*, they are involuntary. These muscles possess striations but they never get fatigued as the myofibrils of heart have transverse faint dark and light bands which alternate with each other giving them striped appearance.

14. **(b)** **Sternum** is a flat bone present just underneath the skin in the middle of the front of the chest.
**Glenoid Cavity** is the depression which articulates with the head of the humerus to form the ball and socket joint in the pectoral girdle.
**Freely Movable Joints** are characterised by the presence of a fluid filled synovial cavity between the articulating surface of the two bones. This fluids represents the **synovial fluid**, e.g., in gliding and hinge joints.
**Cartilagenous Joints** are present between the adjacent vertebrae in the vertebral column.

## Past Years NEET

15. **(c)** Sustained contraction with no relaxation phase is called muscle **tetanus**.

16. **(c)** Calcium is responsible for unmasking of active sites for cross-bridge activity during muscle contraction.

17. **(d)** In human, 12 pairs of ribs are present out of which first 7 pairs of ribs (1st to 7th pair) are called true ribs and they are **dorsally attached to vertebral column** and ventrally to the sternum.

18. **(b)** Pivot joint is a type of synovial joint which provides free movement between atlas and axis vertebrae of vertebral column.

19. **(a)** The **sarcoplasmic reticulum** to release calcium ions into the muscle interior where they bind to troponin, thus causing tropomyosin to shift from the face of the actin filament to which myosin heads need to bind to produce contraction.

20. **(d)** Alzheimer's disease is a neurodegenerative disorder due to deficiency of neurotransmitter acetylcholine. Rheumatoid arthritis is an autoimmune disorder in which antibodies are produced against the synovial membrane and cartilage. Vitiligo causes white patches on skin also characterized as autoimmune disorder. Psoriasis is a skin disease that causes itchy or sore patches of thick red skin and is also autoimmune.

21. **(d)** Osteoporosis has 3 causes: excess parathyroid hormone, advanced age, and lack of estrogen in older females. Estrogen promotes the activity of osteoblast and inhibits osteoclast. Parathormone promotes mobilisation of calcium from bone into blood. Excessive activity of parathormone causes demineralisation leading to osteoporosis.

22. **(a)** The sarcoplasmic reticulum to release calcium ions into the muscle interior where they bind to **troponin**, thus causing tropomyosin to shift from the face of the actin filament to which myosin heads need to bind to produce contraction. The given diagram shows the process of muscle contraction.

23. **(d)** There are 12 pairs of ribs in human body. First seven pairs are attached to the **sternum** ventrally with the help of hyaline carlilage, also called as true ribs. These are called vertebrosternal ribs. The next three pairs ($8^{th}$, $9^{th}$ and $10^{th}$) do not articulate directly with the sternum, also called vertebrochondral (false) ribs . The last two pairs ($11^{th}$ and $12^{th}$) are the free floating ribs because they are not connected ventrally.

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

25. **(b)** **Muscular dystrophy** is a inheritable disease that gradually cause the muscles to weaken, leading to an increasing level of disability.
Tetany, Myasthenia gravis and Botulism are not inheritable diseases.

26. **(c)** 11*th* and 12*th* pairs of ribs are not connected ventrally and are therefore, 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 the thorax between **2*nd*** **and the 7*th*** **rib**. Glenoid cavity of scapula articulates with head of the humerus to form the shoulder joint.

**27.** **(b)** Muscle contraction is initiated by the signal that is sent by the central nervous system. In this process certain events occurs such as
(a) the head of the myosin hydrolyses ATP molecule and binds with the active sites of actin and forms the cross bridge.
(b) The z-line that is connected with actins are pulled inwards and thus causes the shortening of the sarcomeres.
(c) During the contraction of muscle, 'I' bands reduces and A bands remain the same.
(d) AD P + Pi are released by myosin and goes back to the relaxed condition.
So option (b) is correct.

**28.** **(a)** Scapula is a large triangular flat bone situated in the dorsal part of the thorax between the second and the seventh ribs.
Fibrous joint is shown by the flat skull bones which fuse end-to-end with the help of dense fibrous connective tissues in the farm of sutures, to form cranium.
Sternum is a flat bone on the ventral midline of thorax.
Cartilaginous joints between the adjacent vertebrae in the vertebral column permits limited movement.

**29.** **(d)**
- Myasthenia gravis is a chronic auto immune disorder affecting neuromuscular junction leading to fatigue, weakening and paralysis of skeletal muscle.
- Gout is caused due to deposition of uric acid crystal in joints leading to its inflammation.
- Inflammation of joints is commonly known as arthritis.
- Muscular dystrophy is a genetic disorder which results in progressive degeneration of skeletal muscle.

**30.** **(b)** Osteoporosis is a age-related disorder characterised by decreased bone mass and increased chances of fractures. Common cause of osteoporosis is due to decreased levels of estrogen.

**31.** **(d)** **Arthritis:** Inflammation of joints.
**Myasthenia gravis:** Auto immune disorder affecting neuromuscular junction leading to fatigue, weakening and paralysis of skeletal muscle.
**Muscular dystrophy:** Progressive degeneration of skeletal muscle mostly due to genetic disorder.
Tetany: Rapid spasms (wild contractions) in muscle due to low Ca++ in body fluid.

**32.** **(b)** Muscle bundles are held together by collagenous connective tissue layer called fascia. Muscle bundles are called fascicles. The portion of the myofibril between two functional unit of contraction called sarcomere.

**33.** **(b)** The correct matching will be:
Cartilaginous joint is present between the adjacent vertebrae in the vertebral column.
Ball and socket joint is present between between Humerus and Pectoral girdle
Fibrous Joint is present between between flat skull bones
Saddle Joint is present between between carpal and metacarpal of thumb

**34.** **(d)** A-III, B-I, C-IV, D-II.

## EXERCISE - 3

**1.** **(d)** A – III; B – IV; C – II; D – I
**2.** **(a)** A – I; B – II; C – III; D – IV
**3.** **(a)** A – II; B – IV; C – I; D – III
**4.** **(b)** A – II; B – III; C – IV; D – I
**5.** **(c)** A – IV; B – III; C – I; D – II
**6.** **(b)** Clavicle and glenoid cavity belongs to pectoral girdle rather than pelvic girdle. Hence, it is incorrectly paired.
**7.** **(d)**
**8.** **(b)** Muscle is a specialised tissue of mesodermal origin. About 40-50% of the body weight of a human adult is contributed by muscles.
**9.** **(d)** H-zone is the central part of the thick filament, which is not opverlapped by the thin filaments.
**10.** **(b)** Muscle contraction is initiated by signals sent by CNS via a motor neuron.
**11.** **(a)** Since statement (i) and (iv) are correct.
**12.** **(a)**
**13.** **(a)** Muscle fibre is a syncytium as the sarcoplasm (cytoplasm of the muscle fibre) contain many nuclei.
**14.** **(d)**
- Muscle fatigue occurs due to lactic acid formation.
- Muscle contraction require ATP for the formation and breakdown of cross-bridge.

**15.** **(d)** **Smooth muscles** are not branched and cylindrical in appearance. Involuntary muscles are striated.
**16.** **(c)** Events (i), (ii), (iv) and (v) only occurs during muscle contraction. Concentration of myoglobin, red coloured oxygen storing pigment, in muscle fibres increases.
**17.** **(a)** **Synovial fluid** is a thick sticky fluid secreted by synovial membranes into the synovial cavity. Though the presence of synovial fluid is one of the reasons behind the mobility of the joints, but the most accurate reason is the arrangement of the bones at the joint. The spheroidal ball-like end of one bone articulates with the cup-shaped depression in another which allows the bone with the ball head to be moved freely in many planes. Shoulder joints and hip joints are the ball-and-socket joints.
**18.** **(b)** Arthritis or inflammation of a joint makes the joint painful and may even immobilise the movements at the joint. This may result from a lack of the synovial fluid at the joint. The ossification of the articular cartilage, deposition of uric acid crystals in the joint cavity or other changes at the joint.
**19.** **(b)** The phase of muscle contraction occurs when myosin binds and releases actin. Muscle contraction is initiated by a signal sent by the central nervous system via a motor neuron. A motor neuron along with the muscle fibres connected to it constitutes a motor unit.

20. **(d)** Painful inflammation of the synovial membrane of the joints results in stiffening of joints and painful movement. Uric acid accumulation in the joints can lead to painful movement of joint.
21. **(a)** Main movements found in unicellular organisms are ciliary, flagellar and amoeboid movements. In multicellular animals also, phagocytes migrate through tissues by amoeboid movements. Ciliary movement of cells lining the upper respiratory tract, fallopian tubes and vasa efferentia of testes transport, respectively dust particles, ova and sperms in specific direction in those organs. Mammalian sperms move into the female reproductive tract by flagellar movements.

## EXERCISE - 4

1. **(d)** Vertebral column is a spring like vertebrae which lies in the mid-dorsal line of the neck and trunk. The correct order of vertebral region from superior to inferior are Cervical-thoracic-lumbar-sacrum-coccyx.
2. **(d)** A - 2F, B - tropomyosin, C - troponin
The thin filaments of myofibril contain 2F actin and two filaments of tropomyosin protein along with the troponin protein for masking binding sites for myosin.
3. **(d)** **Red muscle fibre** (or Type I, slow twitch muscle fibre) is dense with capillaries and is rich in mitochondria and myoglobin, giving the muscle tissue its characteristic red color. It can carry more oxygen and sustain aerobic activity using fats or carbohydrates as fuel. Slow twitch fibers contract for long periods of time but with little force. White muscle fibre (or Type II, fast twitch muscle fibre) contract quickly and powerfully but fatigue very rapidly, sustaining only short, anaerobic bursts of activity before muscle contraction becomes painful. They contribute most to muscle strength and have greater potential for increase in mass. Type II is anaerobic, glycolytic, **"white" muscle** that is least dense in mitochondria and myoglobin.
4. **(b)** The label I, II, III and IV respectively are humerus, radius, ulna and scapula.
5. **(c)** The soft area is a gel-like substance in the middle of spinal cord. It represents the remnant of notocord.
6. **(b)** (A)- Clavicle, (B)- Scapula, (C)- Tetany, (D)- Fascicles, (E)- Fascia
7. **(d)** Rigor mortis is the rigidity that develops in dying muscles as ATP becomes depleted and cross-bridges remain attached. Rigor mortis can be relieved only by removal of $Ca^{2+}$ and addition of ATP.
8. **(d)** Scapula (X) is a large triangular flat bone situated in the dorsal part of the thorax between the second (Y) and the seventh ribs.
9. **(c)**
10. **(d)** All of the given statements are correct.