# Chapter 20. Locomotion and Movement

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

**2.** 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.

| | |
|---|---|
| (a) $X = 12$, $Y = 5$ | True ribs are attached dorsally to vertebral column and sternum on the two ends |
| (b) $X = 24$, $Y = 2$ | The 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 |

*(NEET 2017)*

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

**4.** Osteoporosis, an age-related disease of skeletal system, may occur due to
(a) immune disorder affecting neuromuscular junction leading to fatigue
(b) high concentration of $Ca^{++}$ and $Na^{+}$
(c) decreased level of estrogen
(d) accumulation of uric acid leading to inflammation of joints. *(NEET-II 2016)*

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

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

**7.** Which of the following joints would allow no movements?
(a) Synovial joint
(b) Ball and Socket joint
(c) Fibrous joint
(d) Cartilaginous joint
*(2015)*

**8.** Sliding filament theory can be best explained as
(a) actin and myosin filaments do not shorten but rather slide pass each other
(b) when myofilaments slide pass each other, myosin filaments shorten while actin filaments do not shorten
(c) when myofilaments slide pass each other actin filaments shorten while myosin filaments do not shorten
(d) actin and myosin filaments shorten and slide pass each other.
*(2015 Cancelled)*

**9.** Glenoid cavity articulates
(a) clavicle with scapula
(b) humerus with scapula
(c) clavicle with acromion
(d) scapula with acromion.
*(2015 Cancelled)*

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

| | Type of joint | | Example |
|---|---|---|---|
| (a) | Cartilaginous joint | – | Between frontal and parietal |
| (b) | Pivot joint | – | Between third and fourth cervical vertebrae |
| (c) | Hinge joint | – | Between humerus and pectoral girdle |
| (d) | Gliding joint | – | Between carpals |

*(2014)*

**11.** Stimulation of a muscle fiber by a motor neuron occurs at
(a) the neuromuscular junction
(b) the transverse tubules
(c) the myofibril
(d) the sacroplasmic reticulum. *(2014)*

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

**13.** The H-zone in the skeletal muscle fibre is due to
(a) the central gap between actin filaments extending through myosin filaments in the A-band
(b) extension of myosin filaments in the central portion of the A-band
(c) the absence of myofibrils in the central portion of A-band
(d) the central gap between myosin filaments in the A-band. (*NEET 2013*)

**14.** The characteristic and an example of a synovial joint in humans is

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

(*NEET 2013*)

**15.** During muscle contraction in humans, the
(a) sarcomere does not shorten
(b) A band remains same
(c) A, H and I bands shorten
(d) actin filaments shorten.
(*Karnataka NEET 2013*)

**16.** Select the correct statement with respect to disorders of muscles in humans.
(a) Failure of neuromuscular transmission in myasthenia gravis can prevent normal swallowing.
(b) Accumulation of urea and creatine in the joints causes their inflammation.
(c) An overdose of vitamin D causes osteoporosis.
(d) Rapid contractions of skeletal muscles cause muscle dystrophy.
(*Karnataka NEET 2013*)

**17.** Select the correct statement regarding the specific disorder of muscular or skeletal system.
(a) Muscular dystrophy – Age related shortening of muscles
(b) Osteoporosis – Decrease in bone mass and higher chances of fractures with advancing age
(c) Myasthenia gravis – Autoimmune disorder which inhibits sliding of myosin filaments
(d) Gout – Inflammation of joints due to extra deposition of calcium *(2012)*

**18.** Which one of the following pairs of chemical substances, is correctly categorised?
(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
*(2012)*

**19.** The type of muscle present in our
(a) heart is involuntary and unstriated smooth muscle
(b) intestine is striated and involuntary
(c) thigh is striated and voluntary
(d) upper arm is smooth muscle and fusiform in shape. *(2011)*

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

| | **Pair of skeletal parts** | **Category** |
|---|---|---|
| (a) | Sternum and ribs | Axial skeleton |
| (b) | Clavicle and glenoid cavity | Pelvic girdle |
| (c) | Humerus and ulna | Appendicular skeleton |
| (d) | Malleus and stapes | Ear ossicles |

*(2011)*

**21.** Which one of the following is the correct description of a certain part of a normal human skeleton?
(a) Parietal bone and the temporal bone of the skull are joined 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. *(2010)*

**22.** Which one of the following is the correct matching of three items and their grouping category?

| | **Items** | **Group** |
|---|---|---|
| (a) | Ilium, ischium, pubis | Coxal bones of pelvic girdle |
| (b) | Actin, myosin, rhodopsin | Muscle proteins |
| (c) | Cytosine, uracil, thiamine | Pyrimidines |
| (d) | Malleus, incus, cochlea | Ear ossicles |

*(2009)*

**23.** Elbow joint is an example of
(a) hinge joint
(b) gliding joint
(c) ball and socket joint
(d) pivot joint. *(2009)*

**24.** Which one of the following items gives its correct total number?
(a) Types of diabetes-3
(b) Cervical vertebrae in humans-8
(c) Floating ribs in humans-4
(d) Amino acids found in proteins-16 *(2007)*

**25.** In human body, which one of the following is anatomically correct?
(a) Collar bones - 3 pairs
(b) Salivary glands - 1 pair
(c) Cranial nerves - 10 pairs
(d) Floating ribs - 2 pairs *(2007)*

**26.** The contractile protein of skeletal muscle involving ATPase activity is
(a) troponin (b) tropomyosin
(c) myosin (d) □-actinin. *(2006)*

**27.** An acromian process is characteristically found in the
(a) pelvic girdle of mammals
(b) pectoral girdle of mammals
(c) skull of frog
(d) sperm of mammals. *(2005)*

**28.** Which of the following pairs is correctly matched?
(a) Hinge joint - Between vertebrae
(b) Gliding joint - Between zygapophyses of the successive vertebrae
(c) Cartilaginous joint - Skull bones
(d) Fibrous joint - Between phalanges
*(2005)*

**29.** What will happen if ligaments are torn ?
(a) Bones will move freely at joint and no pain.
(b) Bone less movable at joint and pain.
(c) Bone will become unfixed.
(d) Bone will become fixed. *(2002)*

**30.** Which cartilage is present at the end of long bones?
(a) Calcified cartilage
(b) Hyaline cartilage
(c) Elastic cartilage
(d) Fibrous cartilage *(2002)*

**31.** Which statement is correct for muscle contraction?
(a) Length of H-zone decreases
(b) Length of A-band remains constant
(c) Length of I-band increases
(d) Length of two Z-line increases *(2001)*

**32.** What is sarcomere?
(a) Part between two H-line
(b) Part between two A-line
(c) Part between two I-band
(d) Part between two Z-line *(2001)*

**33.** Sternum is connected to ribs by
(a) bony matter
(b) white fibrous cartilage
(c) hyaline cartilage
(d) areolar tissue. *(2000)*

**34.** Bone related with skull is
(a) coracoid (b) arytenoid
(c) pterygoid (d) atlas. *(2000)*

**35.** What is the name of joint between ribs and sternum?
(a) Cartilaginous joint
(b) Angular joint
(c) Gliding joint
(d) Fibrous joint *(2000)*

**36.** The joint between atlas and axis is called
(a) angular joint (b) hinge joint
(c) pivot joint (d) saddle joint. *(1999)*

**37.** Which of the following is the contractile protein of a muscle?
(a) Tropomyosin (b) Tubulin
(c) Myosin (d) All of these *(1998)*

**38.** The functional unit of contractile system in striated muscle is
(a) sarcomere (b) Z-band
(c) cross bridges (d) myofibril. *(1998)*

**39.** Total number of bones in each limb of a man is
(a) 24 (b) 30
(c) 14 (d) 21. *(1998)*

**40.** When a muscle bends one part upon the other, it is called
(a) abductor (b) regulator
(c) extremor (d) flexor. *(1996)*

**41.** The number of floating ribs in the human body is
(a) 3 pairs (b) 2 pairs
(c) 6 pairs (d) 5 pairs. *(1995)*

**42.** Which of the following components is a part of the pectoral girdle?
(a) Sternum (b) Acetabulum
(c) Glenoid cavity (d) Ilium *(1994)*

**43.** The type of joint between the human skull bones is called
(a) cartilaginous joint
(b) hinge joint
(c) fibrous joint
(d) synovial joint. *(1994)*

**44.** The cervical vertebrae in human is
(a) same as in whale
(b) more than that in rabbit
(c) double than that of horse
(d) less than that in giraffe. *(1993)*

**45.** Long bones function in
(a) support
(b) support, erythrocyte and leucocyte synthesis
(c) support and erythrocyte synthesis
(d) erythrocyte formation. *(1993)*

**46.** Number of cervical vertebrae in camel is
(a) more than that of rabbit
(b) less than that of rabbit
(c) same as that of whale
(d) more than that of horse. *(1993)*

**47.** A deltoid ridge occurs in
(a) radius (b) ulna
(c) femur (d) humerus. *(1990)*

**48.** Extremities of long bones possess which of the following cartilages?
(a) Calcified (b) Fibrous
(c) Elastic (d) Hyaline *(1989)*

**49.** Intercostal muscles occur in
(a) abdomen (b) thigh
(c) ribs (d) diaphragm. *(1988)*

**Answer Key**

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.** | (b) | **2.** | (d) | **3.** | (a) | **4.** | (c) | **5.** | (a) | **6.** | (a) | **7.** | (c) | **8.** | (a) | **9.** | (b) | **10.** | (d) |
| **11.** | (a) | **12.** | (d) | **13.** | (a) | **14.** | (a) | **15.** | (b) | **16.** | (a) | **17.** | (b) | **18.** | (c) | **19.** | (c) | **20.** | (b) |
| **21.** | (a) | **22.** | (a) | **23.** | (a) | **24.** | (c) | **25.** | (d) | **26.** | (c) | **27.** | (b) | **28.** | (b) | **29.** | (b) | **30.** | (b) |
| **31.** | (a,b) | **32.** | (d) | **33.** | (c) | **34.** | (c) | **35.** | (a) | **36.** | (c) | **37.** | (c) | **38.** | (a) | **39.** | (b) | **40.** | (d) |
| **41.** | (b) | **42.** | (c) | **43.** | (c) | **44.** | (a) | **45.** | (b) | **46.** | (c) | **47.** | (d) | **48.** | (d) | **49.** | (c) | | |

# EXPLANATIONS

**1. (b)** **2. (d)**

**3. (a) :** Calcium ion plays an important role in muscle contraction. Calcium ions bind to troponin causing a change in its shape and position. Thus, in turn alters shape and position of tropomyosin to which troponin binds. This shift exposes the active sites on F-actin molecules. Myosin cross-bridge are then able to bind to these active sites.

**4. (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 estrogen levels in blood plasma are much reduced. Estrogen helps to regulate bone cells called osteoclasts which are responsible for building new bone. When estrogen levels drop fewer osteoclasts are produced resulting in osteoporosis.

**5. (a) :** Tetanus refers to continued state of contraction of a muscle resulting from the summation of a series of rapid muscular contractions (twitches) that are induced by repeated stimulation of the muscle.

**6. (a)**

**7. (c) :** Fibrous or immovable joints are the joints in which no movement occurs between the bones concerned. White fibrous tissue is present between the ends of the bones. Fibrous joint occurs between the bones of the skull called sutures and the joints between the teeth and the maxilla and the teeth and the mandible.

**8. (a) :** During muscle contraction, the laterally projecting heads (cross bridges) of the thick myosin myofilaments come in contact with the thin actin myofilaments and rotate on them. This pulls the thin myofilaments toward the middle of the sarcomere, past the thick myofilaments. The Z lines come closer together and the sarcomere becomes shorter. Length of the A band remains constant. Myofilaments (both actin and myosin) stay the same length. Free ends of actin myofilaments move closer to the centre of the sarcomere, bringing Z lines closer together. I bands shorten and H zone narrows. A similar action in all the sarcomeres results in shortening of the entire myofibril and thereby of the whole fibre and the whole muscle.

**9. (b) :** Upper rounded end of the humerus (bone of arm) is called head that articulates into the glenoid cavity of the pectoral girdle (shoulder girdle) of scapula or shoulder blade bone.

**10. (d) :**

| | | |
|---|---|---|
| Cartilaginous joint | – | Between the adjacent vertebrae in vertebral column |
| Pivot joint | – | Between atlas and axis |
| Hinge joint | – | Knee joint |
| Ball and socket joint | – | Between head of humerus and glenoid cavity of pectoral girdle |
| Fibrous joint | – | Between frontal and parietal bones of skull (sutures) |

**11. (a) :** A neuron that transmits a stimulus to muscle tissue is called motor neuron. A motor unit consists of a single motor neuron (nerve cell) and the muscle fibres it innervates. The portion of the muscle plasma membrane (sarcolemma) that lies beneath the nerve endings (axon terminals) is called the motor end plate. The axon terminals and the motor end plate together constitute the neuro-muscular junction or neuromotor junction.

**12. (d) :** Thoracic vertebrae are 12 in numbers. Joints between adjacent vertebrae are cartilagenous joints and the opposing surfaces are connected by fibrocartilage which allows very little movement. Osteoporosis is a disease characterised by low bone mass and loss of bone tissue that may lead to weak and fragile bones. Osteoporosis occurs when there is an imbalance between new bone formation and old bone resorption. Generalised osteoporosis is common in elderly people and in women following menopause. In osteoporosis, the osteoblastic (bone forming) activity in the bone usually is less than normal and consequently the rate of bone deposition is depressed. Estrogens inhibit osteoclastic (bone resorption) activity in the bones and therefore stimulate bone growth. After menopause, almost no estrogens are secreted by ovaries. This estrogen deficiency leads to increased osteoclastic activity in the bones, decreased bone matrix and decreased deposition of bone calcium and phosphate. In some women, this effect result in osteoporosis.

**13. (a) :** Each muscle fibre has many parallelly arranged myofibrils. Each myofibril contains many serially arranged units called sarcomere which are the functional units. Each sarcomere has a central 'A' band made of thick myosin filaments and two half 'I'

bands made of thin actin filaments on either side of it marked by 'Z' lines. 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.

**14. (a)** : Joint between atlas and axis is a pivot joint, a type of synovial joint. Synovial joints are characterised by presence of fluid filled cavity between the articulating surface of the two bones.

**15. (b)** : According to sliding-filament theory of muscle contraction, the actin and myosin filaments slide past each other with the help of cross-bridge to reduce the length of the sarcomeres. The smallest unit of muscle contraction is a sarcomere (which is delineated by Z-lines). As a muscle contracts, the Z lines come closer together (shortening sarcomere), the width of the I bands decreases, the width of the H zones decreases, but there is no change in the width of the A band. During relaxation, cross-bridges disappear and actin filaments slide back from A-bands, the width of the I bands and H zones increases, but there is still no change in the width of the A band.

**16. (a)** : Myasthenia gravis is an autoimmune disorder in which autoantibodies bind to cholinergic receptors on muscle cells and impairs the ability of the neurotransmitter acetylcholine to induce muscular contraction. This leads to fatigue, weakening and paralysis of skeletal muscles of mouth and throat which may prevent normal swallowing. Gouty arthritis is caused either due to excessive formation of uric acid or inability to excrete it. It gets deposited in synovial joints and causes inflammation. Osteoporosis is a disease in which bone loses minerals and fibres from its matrix. Major causative factors of osteoporosis are imbalances of hormones like calcitonin of thyroid, parathormone of parathyroids, sex hormones and deficiencies of calcium and vitamin D. Muscular dystrophy is inborn abnormality of muscles associated with dysfunction and ultimately with deterioration.

**17. (b)** : Muscular dystrophy is characterised by progressive skeletal muscle weakness, defects in muscle proteins and the death of muscle cells and tissue.

Myasthenia gravis is an auto-immune neuromuscular disease in which muscle becomes weak, which is caused by circulating antibodies that block acetylcholine receptors at the postsynaptic neuromuscular junction inhibiting the excitatory effects of the acetylcholine.

Gout is inflammation of joints which is caused by elevated levels of uric acid in the blood which crystallises and the crystals are deposited in joints, tendons and surrounding tissues.

**18. (c)** : Skeletal muscle fibres occur in bundles and are normally attached to the skeleton. Each muscle fibre is an elongated cell surrounded externally by a delicate membrane, the sarcolemma. Just beneath the sarcolemma in each fibre many nuclei occur at irregular intervals. Thus, these fibres are mutlinucleated or syncytial in nature. The cytoplasm of each fibre (sarcoplasm) has a large number of myofibrils which are tightly packed. Each myofibril shows dark bands (A bands) containing myosin and light band (I bands) containing actin, alternating with each other. That is why these are named as striped muscle fibres. Actin filaments are thinner as compared to the myosin filaments. Each actin filament is made of two 'F' actins helically wound to each other. Each 'F' actin is a polymer of monomeric 'G' (globular) actins. 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. Each myosin filament is also a polymerised protein made up of many monomeric proteins called meromyosins.

**19. (c)** : Cardiac muscles are found in the wall of the heart. It is involuntary and slightly striated. Smooth muscles are found in gastrointestinal tract. These are non-striated and involuntary. Striated (or skeletal) muscles are found in the limbs and body walls. These muscles are voluntary (under the control of animal's will) and show dark and light bands thus are striated.

**20. (b)** : Each pectoral girdle consists of two bones, clavicle and scapula. The scapula (shoulder blade) consists of a sharp ridge, the spine and a triangular body. The end of the spine projects as a flattened and expanded process called acromion. This process articulates with the clavicle. At the lateral end of the superior of the scapula is projection of the anterior surface called the coracoid process, to which the tendons of the muscles attach. At the point where the superior and lateral borders of the scapula meet there is the lateral angle which presents a shallow articular surface termed as glenoid cavity into which the head of the humer is articulated.

**21. (a)** : The bones of skulls are joined by white fibrous tissue which sustain no movement between the skull bones. This kind of joint is classified as

fibrous or immovable joints. Thus, parietal and temporal bone of the skull are joined by fibrous joints.

First cervical vertebra, atlas, joins the second cervical vertebra axis to form a joint (pivot joint) which allows movement in one plane. The atlas supports the head and allows movement of head over neck.

The last two pairs of ribs are called floating ribs because their anterior ends are not attached to either the sternum or the cartilage of anterior rib.

Glenoid cavity is a depression to which humerus articulates.

**22. (a) :** The pelvic girdle is formed by two innominate bones (hip bones). Each innominate bones consists of three separate bones, ilium, ischium and the pubis.

**23. (a) :** 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. Examples are - knee joint and elbow joint.

**24. (c) :** There are twelve pairs of ribs which form the bony lateral walls of the thoracic cage. The first seven pairs are called true ribs; eight, ninth and tenth pairs are called false ribs. The last two pairs of ribs are called floating ribs because their anterior ends are not attached either to the sternum or the cartilage of another rib. The floating ribs protect the kidneys.

**25. (d) :** Collar bones (Clavicle) – 2 pairs
Salivary glands – 3 pairs
Cranial nerves – 12 pairs

**26. (c) :** Myosin is a contractile protein that interacts with actin to bring about contraction of muscle or cell movement. The type of myosin molecule found in muscle fibres consists of a tail, by which it aggregates with other myosin molecules to form so-called thick filaments and a globular head, which has sites for the attachment of actin and ATP molecule. Troponin, tropomyosin and a-actinin are the actin in the thin filament.

**27. (b) :** Each half of pectoral girdle is made up of two bones scapula and clavicle. At the outer angle of scapula is a shallow socket known as glenoid cavity into which fits head of humerus bone to form a shoulder joint. Above glenoid cavity project two processes - acromion process and coracoid process. Acromion process extends over the glenoid cavity and articulates with clavicle to form shoulder girdle. Coracoid process is like a hook and is smaller than acromion process.

**28. (b) :** Gliding joint permits sliding movements of two bones over each other. Hinge joint allows movements in one plane only. Knee joint, elbow joint, ankle joint are of this type. Cartilaginous joint is a slightly movable joint and is found between the centre of vertebrae, at the pubic symphysis and between ribs and sternum. Fibrous joint is an immovable joint which occur between the bones of cranium.

**29. (b) :** Ligaments join a bone with another bone in movable/synovial joints. Torn ligaments make movement at joints very painful and restricted.

**30. (b) :** Cartilage is an important component of skeleton. It consists of a firm matrix containing collagen and elastin fibres and cells in fluid-filled lacunae. Cartilage has many types. Elastic cartilage occurs in the pinna and external auditory canal of the ear, epiglottis, Eustachian tubes and tip of the nose to make these organs flexible. Fibrous cartilage is very strong yet has a degree of flexibility. It is found in the intervertebral discs where it acts as a cushion and in pubic symphysis where it allows parturition without damage to the girdle. Hyaline cartilage occurs in sternal ribs where it allows expansion of chest during inspiration. It also forms the tracheal and bronchial rings and supports larynx and nasal septum and also at the end of long bones.

**31. (a, b) :** In contraction, the laterally projecting heads (cross bridges) of the thick myosin myofilaments come in contact with the thin actin myofilaments and rotate on them. This pulls the thin myofilaments toward the middle of the sarcomere past the thick myofilaments. The Z lines come closer together and the sarcomere becomes shorter. Length of the A band remains constant. Myofilaments stay the same length. Free ends of actin myofilaments move closer to the centre of the sarcomere, bringing Z lines closer together. I bands shorten and H zone narrows. A similar action in all the sarcomeres results in shortening of the entire myofibril, and thereby of the whole fibre and the whole muscle.

**32. (d) :** A striated muscle fibre is bounded by sarcolemma. It shows alternating dark and light cross bands, the striations. Dark band is called A band which has at its middle a light zone termed H zone. Light band is known as I band which is crossed through its centre by a dark membrane called Z line. The part of the muscle fibre between two successive Z lines functions as a contractile unit called sarcomere.

**33. (c) :** Sternum is connected to ribs by hyaline cartilage (= giving a shiny glass like appearance and gives flexibility and support at the joints). Sternum is also called breast bone. It is a narrow, elongated and flattened structure, present just under the skin in the middle of front of the chest. It consists of three parts - manubrium, mesosternum and xiphoid process.

Manubrium is the thickest, strongest part and articulates with the clavicle of pectoral girdle and first pair of ribs. Mesosternum provide articulation to second to sixth pairs of ribs and xiphoid process (also called metasternum) articulates with seventh pair of ribs in association with mesosternum.

**34. (c) :** Pterygoid is a process that extends from sphenoid bone of skull to form a plate like structure. Above the glenoid cavity of scapula is present two processes - acromion and coracoid. Coracoid process is like a hook and is smaller that acromion process projecting upwards. Atlas is first cervical vertebra. Arytenoid is a cartilage that forms part of larynx.

**35. (a) :** Cartilaginous joint is present between ribs and sternum. It allows only limited movement. An angular joint allows movement in two directions - side to side and back and forth. Wrist and metacarpophalangeal joints are of this type. Gliding joint permits sliding movements of two bones over each other, *e.g.* joints between sternum and clavicles. Fibrous joints do not allow movement and are present between the bones of cranium.

**36. (c) :** Pivot joint is present between atlas and the axis in humans. In this joint articular end of one bone is fixed while the other can rotate over it. In angular joint, an oval condyle of one bone fits into an elliptical concavity of the other, *e.g.* wrist and metacarpophalangeal joints. Hinge joint allows movements in one plane only, *e.g.* knee joint. In saddle joint, small projection of one bone fits into a saddle-like depression of another bone.

**37. (c) :** Myosin is a contractile protein of muscle. Primary myofilaments are made up of this protein. Each myosin filament is a polymerised protein made of many monomeric protein called meromyosins. Secondary myofilaments are composed of a protein actin, having with it two regulatory proteins : tropomyosin and troponin. Myosin interacts with actin to bring about contraction of muscle or cell movement. Tubulin is a protein of which the microtubules of cells are formed.

**38. (a) :** *Refer to answer 32.*

**39. (b)**

**40. (d) :** Flexor muscle bends one part of a limb on another at a joint, *e.g.*, biceps. It brings the fore arm towards the upper arm. Flexor work antagonistically with extensors. Abductor (levator) is a type of muscle whose function is to move a limb away from the body. *E.g.*, deltoides of shoulder.

**41. (b) :** *Refer to answer 24.*

**42. (c) :** The pectoral girdle lies on the posterolateral aspect of the upper region of the thorax. It consists of 2 bones : scapula and clavicle. The scapula, also called shoulder blade, is a large, flat, triangular bone placed at the back of the shoulder. It has at its lateral angle a shallow concavity, the glenoid cavity, for the articulation of the head of the humerus. Acetabulum and ilium are parts of pelvic girdle. Sternum is a long, narrow, flat vertical bone in the middle of the front wall of the chest.

**43. (c) :** Fibrous joint is present between the human skull bones. It does not allow movement because the bones are held firmly together by bundles of strong white collagen fibres. Cartilaginous joints are present between the centra of vertebrae, at the pubic symphysis and between ribs and sternum. Knee joint, elbow joint and ankle joint are types of hinge joint. Synovial joint occurs between limb and bones.

**44. (a) :** The number of cervical vertebrae are same in man and whale that is 7 in number.

**45. (b) :** Long bones strengthen the legs and arms, provide support and also synthesise erythrocytes and leucocytes due to presence of bone marrow in their cavities.

**46. (c) :** The vast majority of mammals have seven cervical vertebrae (neck bones), including camel, bats, giraffes, whales and humans. The few exceptions include the manatee and the two-toed sloth, which each have only six cervical vertebrae and the three-toed sloth with nine cervical vertebrae.

**47. (d) :** In the humerus bone, pectoral and deltoid ridges are important points of muscle attachment.

**48. (d) :** Hyaline cartilage has a clear, homogeneous, translucent, bluish-green matrix. It often contains a good number of very fine collagen fibres, which are difficult to observe. This cartilage is flexible, elastic and compressible. It is found in the sternal ribs, extremities of leg bones, tracheal and bronchial rings, laryngeal wall, nasal septum and superscapula. Elastic cartilage is found in the pinna, epiglottis, Eustachian tubes and tip of nose. Calcified cartilage is found in the suprascapula of frog. Fibrous cartilage is found in the intervertebral discs and pubic symphysis.

**49. (c) :** Intercostal muscles (external intercostal and internal intercostal) are attached with the ribs which help in the movement of rib cage during breathing.