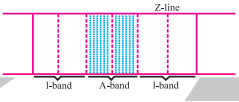


Chapter - 20

Locomotion and Movement

Points To Remember

Arthritis : an inflammatory joint disease characterised by inflammation of joints.

Coccyx : tail bone formed by fusion of four coccygeal vertebrae in man.

Dicondylic Skull : A Skull with two occipital condyles.

Endo Skeleton : A skeleton present in side the body.

Fascicle : Bundles of muscles fibres held together by connective tissue.

Fascia : Collagenous connective tissue layer that surrounds muscle bundles.

Floating ribs : The ribs that remain free anteriorly, **(last 2 pairs)**

False ribs : 8th, 9th and 10th pair of ribs not directly joins the sternum but to seventh pair of ribs, hence called pseudoribs.

Myoglobin : A red colored pigment present in sarcoplasm of muscle.

Sarcomere : A portion of myofibril between two successive 'Z' lines.

Sarcolema : The plasma membrane of a muscle.

Gout : Inflammation of joints due to accumulation of uric acid crystal.

Suture : immovable joints between skull bones.

Synovial joints : Freely movable joints between limb bones.

Patella : A seasmoid bone acting as kneecap.

Intervertebral disc : Fibro cartilaginous pad present between the vertebrae that act as shock absorbers.

Tendon—Connective tissue made of yellow fibrous tissue which connect muscle to bone. It is not flexible.

Ligament—Connective tissue made of white fibrous tissue which joins two bones. It is flexible.

LMM : Light meromyosin

HMM : Heavy meromyosin

Types of Movement :

1. **Amoeboid movement :** These movements takes place in phagocytes where leucocytes and macrophages migrate through tissue. It is affected by pseudepodia formed by the streaming of protoplasm (as in amoeba)
2. **Ciliary movement :** This movement occurs in internal organs which are lined by ciliary epithelium.
3. **Muscular Movement :** This movement involves the muscle fibers, which have the ability to contract and relax.

   Properties of Muscle : (i) Excitability (ii) Contractility (iii) Extensibility (iv) Elasticity

Types of Muscles :

(a) Skeletal muscles or striated muscles—These are involved in locomotion and change of body postures. These are also known as voluntary muscles.

(b) Visceral muscles or smooth muscles—These are located in inner walls of hollow visceral organs, smooth in appearance and their activity are not under control of voluntary nervous system. They are called involuntary muscles.

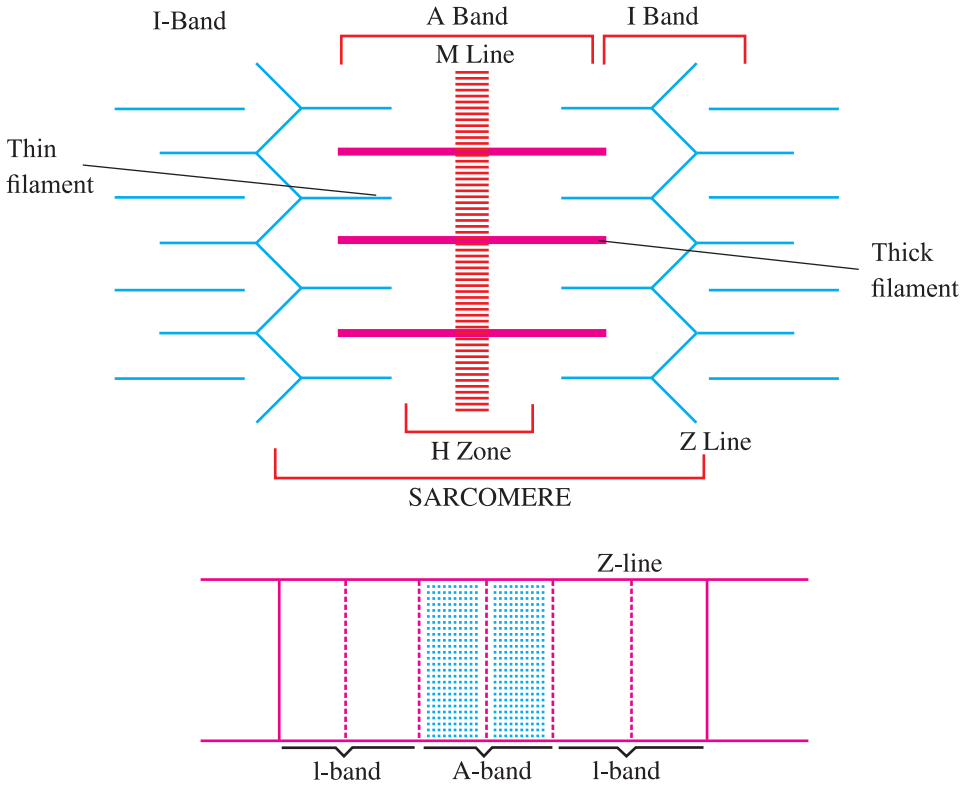
(c) Cardiac muscles—The muscles of heart, involuntary in nature, striated and branched, These are uninucleated.

Characteristic	Skeletal Muscle	Smooth Muscle	Cardiac Muscle
Location	Muscles attached with skeletal components	muscles found in the inner walls of hollow visceral organs	Muscles found only in heart.
Appearance	Striated having light and dark bands. Multi-nucleated	unstriped, smooth in appearance with tapering ends. Uninucleated	Striated in appearance and branched, uninucleated
Control	They are controlled by our will hence called voluntary muscles.	They are not under the control of our will hence called involuntary muscles.	not under the direct control of nervous system.

Structure of myofibril :

- Each myofibril consist of alternate dark and light band.
- Dark band—contain myosin protein and is called A-band or Anisotroic band.
- Light band—Contain actin protein and is called I Band or Isotropic band.
- I Band is bisected by an elastic fiber called 'Z' line. Actin filament (thin filament) are firmly attached to the 'Z' lines.
- Myosin filament (thick filament) in the 'A' Band are also held together in the middle of T Band by thin fibrous membrane called 'M' line.
- The portion between two successive 'Z' lines is considered as functional unit of contraction and is called a sarcomere.

Structure of Actin and Myosin Filament



1. **Actin filament :** An actin filament is made of two 'F' actins which are helically wound to each other. Two filaments of tropomyosin protein also run close to 'F' actins throughout its length. A complex protein Troponin is distributed at regular intervals on tropomyosin which mask the actin binding site for myosin.
2. **Myosin filament :** Each myosin filament is a polymer of meromyosin. Each meromyosin has two components—a globular head with a short arm and a tail. Head is made of heavy meromyosin while tail is made of light meromyosin. The head with its short arm project outward at regular distance and angle from each other and is known as cross arm. The head has an active site for actin and binding site for ATP.

Red muscle fibres :

— These are red in colour due to presence of high content of myoglobin.
— These contain plenty of mitochondria.
— Sarcoplasmic reticulum is less in these fibres.
— Show slow but sustained contractions for longer periods.

White muscle fibres

— These are pale or whitish due to presence of less content of myoglobin.

— These contain fewer mitochondria

— Sarcoplasmic reticulum is more/high

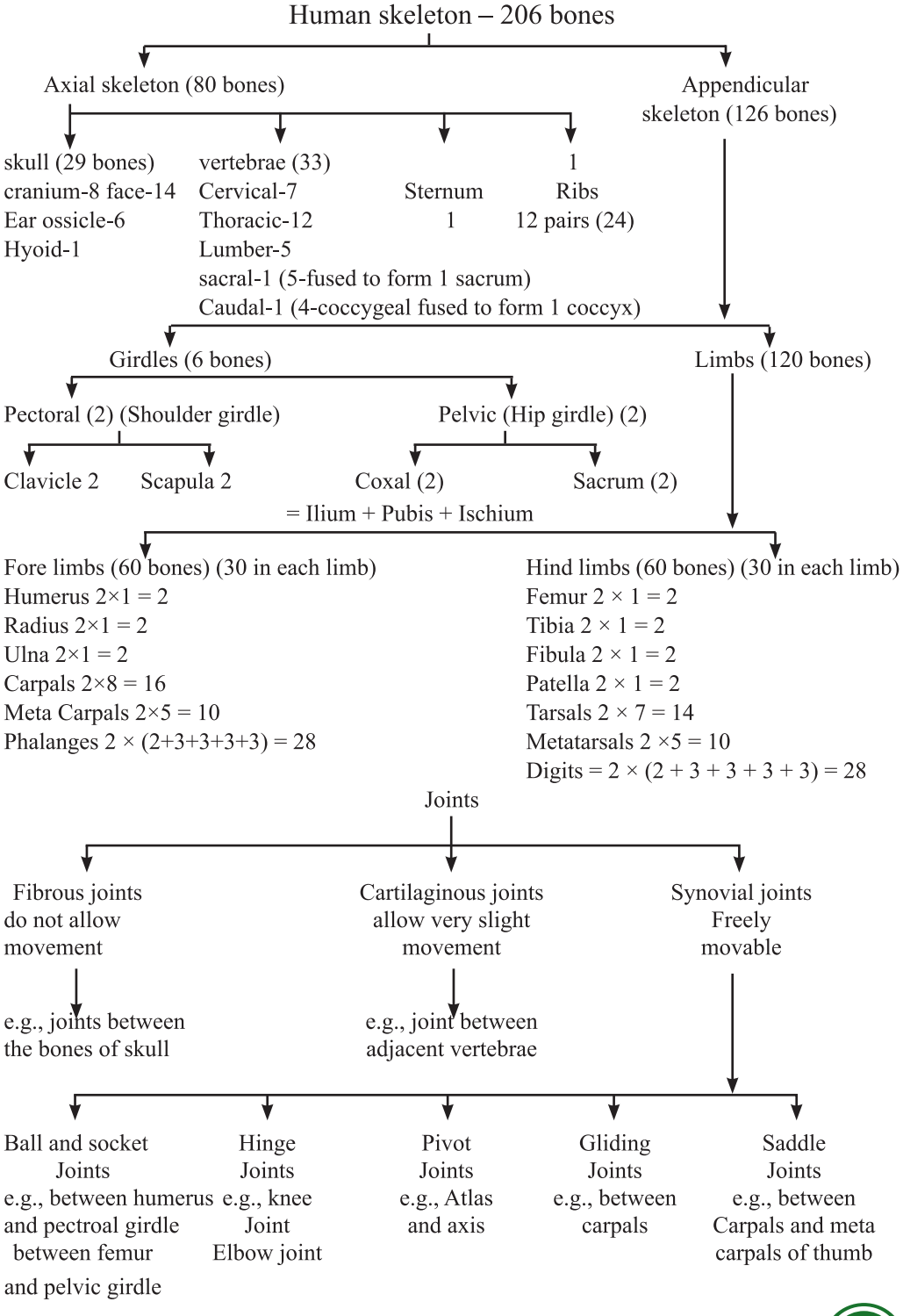
— During sternous exercise, lactic acid accumulates in large quantity so muscle fatigues

Mechanism or Muscle contraction : Sliding filament theory

The contraction of muscle fiber takes place by the sliding of actin (thin filament) on myosin (thick filament)

- Muscle contraction is initiated by a signal sent by the CNS via a motor neuron.
- Impulse from motor nerve stimulates a muscle fiber at neuro muscular junctions.
- Neurotransmitter releases here which generates an action potential in sarcolema.
- This causes release of Ca^{++} into sarcoplasm. These Ca^{++} binds with troponin, thereby remove masking of active site for myosin.
- Myosin head binds to exposed active site on actin to form a cross bridge, utilising energy from ATP hydrolysis.
- This pulls the actin filament towards the centre of 'A' band.
- 'Z' lines also pulled inward thereby causing a shortening of sarcomere i.e. contraction.
- I band get reduced, whereas the 'A' band retain the length.
- During relaxation, the cross bridge between the actin and myosin break. Ca^{++} pumped back to sarcoplasmic cisternae. Actin filament slide out of 'A' band and length of I band increase. This returns the muscle to its original state.

Vertebral formulae of man $C_7T_{12}L_5S_{(5)}C_{(4)} = 33$



Questions

(SRT) Select Response Type Question (1 mark each)

1. What is the total number of bones present in the left pectoral girdle and left arm respectively. In human beings?
   (a) 4, 30 (b) 2, 30
   (c) 4, 30 (d) 2, 32
2. Skeletal muscles show striation because of
   (a) Pattern of troponin and tropomyosin
   (b) pattern of actin and kinetin
   (c) pattern of actin and myosin
   (d) none of these
3. Which pair of ribs are called floating ribs
   (a) 9th and 10th (b) 11th and 12th
   (c) 7th and 6th (d) 10th and 11th

CONSTRUCTED RESPONSE TYPE (CRT)

Very Short Answer Questions (1 mark each)

4. Name the proteins making up dark and light bands of myofibrils.
5. Write the name of chemical that causes fatigue in the muscles.
6. What lubricates the freely movable joints at the shoulder ?
7. Name the longest bone of human body.
8. Give the name of first vertebra.
9. Define a sarcomere.
10. Name the cup shaped bone that constitutes the knee cap.
11. Which muscle fibre work during long flight of eagle ?
12. Name the cavity in the girdle into which the head of femur fits ?

Short Answer Questions-I (2 marks each)

13. Write any two difference between cardiac muscle and skeletal muscle.
14. Distinguish between red fibre and white fibre.
15. Name the two types of girdles found in human body and write their role.
16. State the role of calcium ions and ATP in muscle contraction.
17. Name the bones of fore limb (hand) of human body. Give their number in each limb.

Short Answer Questions-II (3 marks each)

18. What makes the synovial joints freely movable ? List any four types of synovial joints.
19. Name the category of bones forming the ribcage. How are these articulated to each other to form the cage ?
20. How are actin and myosin filament arranged in a muscle fibre ?
21. Mention the factor which is responsible for the following :

    (i) Tetany (ii) Gout (iii) Osteoporosis

Long Answer Questions (5 mark each)

22. Explain the important steps of sliding filament theory of muscle contraction.

Case Based/Competency based/Value based question (4 mark each)

23. The muscle fiber is a syncytium. A characteristics features of the muscle fiber is the presence of a large number of parallelly arranged filaments in the sarcoplasm called myofilaments or myofibril. Each myofibril has alternate dark and light bands on it. Visceral muscles are located in the inner walls of hollow visceral organs of the body. They do not have any striation and are smooth in appearance. Many cardiac muscle cells assemble in a branching pattern to form cardiac muscle.

(i) Why is muscle fiber called a syncytium?

(a) As it is aseptate

(b) As it has more than one nuclei

(c) As it has more than one sarcoplasm

(d) As it has dark and light bands

(ii) Give a characteristic feature of muscle fiber.

(a) Presence of myofilaments

(b) Absence of myofilaments

(c) Presence of branching pattern

(d) Spindle shaped appearance

(iii) Name some visceral organs of the human body.

(a) Femur, legs, arms

(b) Oesophagus

(c) Stomach

(d) Both (b) & (c)

(iv) Which type of muscle are located in the inner walls of hollow visceral organs?

(a) Skeletal muscles

(b) Smooth muscles

(c) Cardiac muscles

(d) Smooth muscles & cardiac muscles

(v) Skeletal muscles and smooth muscles are .....

(a) Involuntary and voluntary respectively

(b) Voluntary and involuntary respectively

(c) Both involuntary

(d) Both voluntary

(SRT) Assertion reasoning type questions-II:

DIRECTIONS : In the following questions, a statement of assertion (A) is followed by a statement of the reason (R). Mark the correct choice as :

(a) If both (A) and (R) are correct and (R) is the correct explanation of (A)

(b) If both (A) and (R) true, but (R) is not the correct explanation of (A)

(c) If (A) is true but (R) is false

(d) If both (A) and (R) are false

24. **Assertion :** Fatigue is the inability of muscles to relax.

Reason : It is due to lactic acid accumulation by repeated contractions.

25. **Assertion :** Rapid spasm in the muscle is termed as tetany.

Reason : Tetany is caused by an increase in the blood calcium level.

26. **Assertion :** Radius is shorter than the ulna.

Reason : It has a large olecranon process.

27. **Assertion :** First seven pairs of ribs are called true ribs.

Reason : These ribs are not connected ventrally to the sternum.

28. **Assertion :** Inflammation of a skeletal joint may immobilize the movement of joints.

Reason : Uric acid crystals in the joint cavity and ossification of articular cartilage leads to this condition.

Answers

(SRT) Select Response Type Question (1 mark each)

1. (b) Left pectoral girdle has 2 bones. Left Arm has 30 bones.
2. (c) Due to distribution pattern of actin and myosin protein.
3. (b) These ribs are not ventrally attached to sternum

CONSTRUCTED RESPONSE TYPE (CRT)

Very Short Answers (1 mark each)

4. Myosin and Actin

5. Lactic acid
6. Synovial fluid
7. Femur
8. Atlas
9. A portion of myofibril between two successive 'Z' lines.
10. Patella
11. Red muscle fibre
12. Acetabulum

Short Answers-I (2 marks each)

13. Refer Points to remember of support material.
14. Refer Points to remember
15. Pectoral and Pelvic girdle bones help in articulation of the upper and lower limbs respectively with the axial skeleton.
16. Calcium (Ca^{++}) ions binds with troponin, thereby remove masking sites. ATP hydrolysis gives energy to Myosin head to bind with active site of actin.
17. Refer Points to remember

Short Answers-II (3 marks each)

18. Refer content points to Remember of support
19. Refer content points to Remember of support
20. Refer content points to Remember of support
21. Refer content points to Remember of support

Long Answer (5 marks each)

22. Refer Points to remember
23. (i) (b)
    (ii) (a)
    (iii) (d)

(iv) (b)

(v) (b)

(SRT) Assertion Reason II Answers

24. (a)
25. (c)
26. (b)
27. (c)
28. (a)