

Class: 12th

Subject: Biology

Chapter 16: Support And Movements

Important MCQs:

1. The main difference between plants and animals is:

- (A) Nutrition
- (B) Reproduction
- (C) Locomotion
- (D) Respiration



2. In plants, collenchymatous cells provide support to:

- (A) Adult plants
- (B) Baby plants
- (C) Woody stems
- (D) Leaves

3. In animals, the body support and movement are provided by:

- (A) Collenchyma
- (B) Parenchyma

(C) Muscles, cartilage and bones

(D) Xylem and phloem

4. The main function of stem in a plant is:

(A) Absorption of water

(B) Reproduction

(C) Support and transport between root and aerial parts

(D) Photosynthesis

5. Turgor pressure in plant cells is maintained by:

(A) Cell wall

(B) Vacuole and tonoplast

(C) Nucleus

(D) Cytoplasm

6. Loss of turgor pressure causes the plant to:

(A) Grow faster

(B) Wilt

(C) Produce more leaves

(D) Store food

7. The tonoplast is:

(A) Cell wall of xylem

(B) Membrane around vacuole

- (C) Outer wall of leaf
- (D) Protective tissue

8. The cells with lignified thick secondary walls are:

- (A) Parenchyma
- (B) Collenchyma
- (C) Sclerenchyma
- (D) Cambium

9. The main function of sclerenchyma is:

- (A) Conduction of water
- (B) Mechanical support
- (C) Storage of food
- (D) Photosynthesis



10. Fibers (Tracheids) are:

- (A) Short and irregular
- (B) Long and cylindrical
- (C) Thin-walled and soft
- (D) Round and small

11. Sclereids are commonly found in:

- (A) Root tips
- (B) Seed coats and nut shells

- (C) Phloem
- (D) Leaf epidermis

12. Collenchyma cells provide support to:

- (A) Young herbaceous stems and leaves
- (B) Old woody stems
- (C) Root hairs
- (D) Fruit pulp

13. The increase in thickness (girth) of stem or root is called:

- (A) Primary growth
- (B) Secondary growth
- (C) Apical growth
- (D) Intercalary growth



14. Vascular cambium forms:

- (A) Cork tissue
- (B) Secondary xylem and phloem
- (C) Primary xylem
- (D) Leaf primordia

15. The age of a tree can be determined by counting:

- (A) Number of leaves
- (B) Number of growth rings

(C) Branches

(D) Flowers

16. The movement of plants in response to external or internal stimuli is called:

(A) Growth

(B) Movement

(C) Circulation

(D) Transport

17. Autonomic movements occur due to:

(A) External causes

(B) Internal causes

(C) Both A & B

(D) Unknown factors

18. Phototactic movement is a response to:

(A) Gravity

(B) Water

(C) Light

(D) Chemical

19. Movement of sperms of ferns and mosses towards archegonia is an example of:

(A) Phototactic movement

(B) Chemotactic movement

(C) Hydrotropic movement

(D) Thigmotropic movement

20. Rapid movement in Mimosa pudica (touch-me-not plant) occurs due to:

(A) Photosynthesis

(B) Loss of turgor pressure

(C) Growth hormones

(D) Osmotic gain

21. The swollen base of a leaf petiole is called:

(A) Node

(B) Pulvinus

(C) Bud

(D) Internode

22. Sleep movements in plants are caused by:

(A) Change in temperature

(B) Change in turgor pressure

(C) Growth of new leaves

(D) Presence of hormones

23. The zig-zag movement of young stem tip due to unequal growth is called:

-
- (A) Epinasty
 - (B) Hyponasty
 - (C) Nutation
 - (D) Tropism

24. Thigmotropism occurs in:

- (A) Roots towards water
- (B) Tendrils wrapping around a support
- (C) Flowers opening at night
- (D) Growth towards gravity

25. Movement of roots towards water is called:

- (A) Geotropism
- (B) Hydrotropism
- (C) Chemotropism
- (D) Phototropism

26. The hydrostatic skeleton is found in:

- (A) Earthworm
- (B) Human
- (C) Fish
- (D) Snake

27. In arthropods, the exoskeleton is made up of:

(A) Cellulose

(B) Chitin

(C) Collagen

(D) Calcium phosphate

28. The process of shedding old exoskeleton in arthropods is called:

(A) Regeneration

(B) Moulting or Ecdysis

(C) Metamorphosis

(D) Segmentation

29. The endoskeleton of vertebrates is mainly composed of:

(A) Cartilage and bone

(B) Calcium carbonate only

(C) Chitin and wax

(D) Muscle fibers

30. The living cells of cartilage are known as:

(A) Osteoblasts

(B) Osteocytes

(C) Chondrocytes

(D) Fibrocytes

31. The appendicular skeleton consists of:

-
- (A) Skull and vertebral column
 - (B) Pectoral girdle and appendages, pelvic girdle and appendages ✓
 - (C) Ribs and sternum
 - (D) Vertebrae and ribs

32. The clavicle connects:

- (A) Scapula with humerus
- (B) Scapula with sternum ✓
- (C) Scapula with ribs
- (D) Radius with ulna

33. The fore limb of human consists of:

- (A) Femur, tibia, fibula
- (B) Humerus, radius, ulna, carpals, metacarpals, phalanges ✓
- (C) Scapula, clavicle, ribs
- (D) Pelvic bone, femur, tarsals

34. The ball and socket joint in the fore limb is formed between:

- (A) Humerus and scapula ✓
- (B) Radius and ulna
- (C) Femur and tibia
- (D) Pelvic bone and femur

35. The pelvic girdle is formed by:

-
- (A) Scapula and clavicle
 - (B) Ilium, ischium and pubis
 - (C) Radius, ulna and carpals
 - (D) Femur, tibia and fibula

36. The hinge joint allows movement:

- (A) In all directions
- (B) In two directions
- (C) Only upward
- (D) Only downward

37. Synovial joints are characterized by:

- (A) Presence of cartilage only
- (B) Fluid-filled cavity and fibrous capsule
- (C) Immovable bones
- (D) Lack of connective tissue

38. Osteoporosis mainly occurs in aged women due to:

- (A) High calcium intake
- (B) Decrease in estrogen level
- (C) Excess exercise
- (D) Vitamin C deficiency

39. Rickets in children is caused by deficiency of:

-
- (A) Vitamin C
 - (B) Vitamin D
 - (C) Iron
 - (D) Protein

40. The first stage in bone fracture repair is:

- (A) Bony callus formation
- (B) Hematoma formation
- (C) Soft callus formation
- (D) Remodeling

41. The proteins responsible for muscle contraction are:

- (A) Collagen and keratin
- (B) Actin and myosin
- (C) Tropomyosin and fibrin
- (D) Elastin and melanin

42. The smooth muscles are:

- (A) Striated and voluntary
- (B) Non-striated and involuntary
- (C) Striated and involuntary
- (D) Non-striated and voluntary

43. Cardiac muscles are found in:

-
- (A) Walls of digestive tract
 - (B) Walls of blood vessels
 - (C) Heart wall
 - (D) Skeletal system

44. The skeletal muscles are also called:

- (A) Smooth muscles
- (B) Visceral muscles
- (C) Striated or voluntary muscles
- (D) Involuntary muscles

45. The tendons connect:

- (A) Muscle to bone
- (B) Bone to bone
- (C) Muscle to muscle
- (D) Ligament to bone



46. The smallest contractile unit of a muscle fibre is called:

- (A) Myofibril
- (B) Sarcolemma
- (C) Sarcomere
- (D) Myofilament

47. The thick filaments of myofibrils are composed of:

-
- (A) Actin
 - (B) Myosin
 - (C) Troponin
 - (D) Tropomyosin

48. The Sliding Filament Model of muscle contraction was proposed by:

- (A) Darwin and Lamarck
- (B) Huxley and A.F. Huxley
- (C) Watson and Crick
- (D) Mendel and Morgan

49. The condition in which body muscles become stiff after death is called:

- (A) Osteoporosis
- (B) Rigor mortis
- (C) Arthritis
- (D) Tetany

50. Muscle contraction follows the principle of:

- (A) Partial contraction
- (B) All or none response
- (C) Progressive contraction
- (D) Half response

51. Energy for muscle contraction is directly supplied by:

-
- (A) Glucose
 - (B) ATP
 - (C) Creatine phosphate
 - (D) Oxygen

52. The main source of glucose for muscle cells is:

- (A) Blood plasma
- (B) Stored glycogen in muscles
- (C) Liver cells
- (D) Lactic acid

53. When muscles require extra energy, it is provided by:

- (A) Keratin
- (B) Creatine phosphate
- (C) Collagen
- (D) Myoglobin

54. Under oxygen deficiency, muscles obtain energy through:

- (A) Aerobic respiration
- (B) Anaerobic breakdown of glucose
- (C) Photosynthesis
- (D) Fat oxidation

55. The anaerobic breakdown of glucose in muscles produces:

-
- (A) Pyruvic acid
 - (B) Lactic acid
 - (C) Alcohol
 - (D) Carbon dioxide and water

56. Accumulation of lactic acid in muscles causes:

- (A) Increased energy
- (B) Muscle fatigue
- (C) Muscle growth
- (D) Relaxation of muscles

57. Muscle fatigue is a condition in which:

- (A) Muscle grows larger
- (B) Muscle fails to contract
- (C) Muscle shrinks permanently
- (D) ATP increases

58. The main cause of muscle fatigue is:

- (A) Excess oxygen
- (B) Lack of ATP and ionic imbalance
- (C) Low glucose
- (D) High calcium

59. Continuous contraction of muscles due to no ATP availability is called:

(A) Cramps

(B) Contractures

(C) Tetany

(D) Rigor mortis

60. Tetany is caused due to deficiency of:

(A) Sodium

(B) Calcium

(C) Potassium

(D) Iron

61. Main symptom of tetany is:

(A) Swelling of muscles

(B) Muscle twitches and convulsions

(C) Muscle enlargement

(D) Broken ligaments

62. Cramp is a:

(A) Disease of bones

(B) Tetanic contraction of muscles

(C) Permanent paralysis

(D) Cardiac disorder

63. Muscle cramps usually occur due to:

(A) Low blood sugar and dehydration

(B) High oxygen level

(C) Low carbon dioxide

(D) High calcium level

64. The three main parts of a skeletal muscle are:

(A) Head, neck, and tail

(B) Origin, insertion, and belly

(C) Upper, middle, and lower

(D) Axon, fibre, and myelin

65. The origin of a muscle is the part that:

(A) Moves during contraction

(B) Remains fixed during contraction

(C) Attaches to ligaments

(D) Contains tendons

66. Tendons connect:

(A) Bone to bone

(B) Muscle to bone

(C) Muscle to muscle

(D) Ligament to muscle

67. Ligaments connect:

-
- (A) Muscle to bone
 - (B) Bone to bone ✓
 - (C) Bone to tendon
 - (D) Bone to cartilage

68. The biceps and triceps work as:

- (A) Synergistic muscles
- (B) Antagonistic pair ✓
- (C) Supportive pair
- (D) Parallel pair

69. In Euglena, locomotion occurs with the help of:

- (A) Cilia
- (B) Flagellum ✓
- (C) Pseudopodia
- (D) Tentacles

70. In Paramecium, movement takes place by:

- (A) Flagella
- (B) Cilia ✓
- (C) Setae
- (D) Tube feet

Exercise Short Questions:

(i) What is the cause of cramps?

Answer:

Cramps are caused by low blood sugar, dehydration, and deficiency of electrolytes such as sodium, potassium, and calcium, leading to involuntary muscle contractions.

(ii) What is the difference between tetanus and muscle tetany?

Answer:

- Tetanus is an infectious disease caused by the bacterium *Clostridium tetani*.
- Muscle tetany is a non-infectious condition caused by low calcium levels in the blood, leading to muscle spasms and twitching.

(iii) What is a ligament?

Answer:

A ligament is a strong, fibrous connective tissue that connects one bone to another and helps to stabilize joints.

(iv) What is "nutantion"?

Answer:

Nutation is the movement of the tip of a growing stem or shoot in circular or spiral form, commonly seen in climbing plants during growth.

(v) How many ribs do not attach with the sternum?

Answer:

There are two pairs of ribs (the 11th and 12th pairs) that do not attach to the sternum. They are called floating ribs.

(vi) How is rickets produced?

Answer:

Rickets is produced due to deficiency of Vitamin D, which causes improper calcium and phosphorus metabolism, leading to soft and weak bones in children.

(vii) What is the cause of tetanus?

Answer:

Tetanus is caused by infection with the bacterium *Clostridium tetani*, which enters the body through wounds and releases a toxin that affects the nervous system, causing severe muscle stiffness and spasms.

(viii) How is muscle fatigue produced?

Answer:

Muscle fatigue is produced when muscles work for a long time without sufficient oxygen. In this condition, muscles respire anaerobically and form lactic acid. The accumulation of lactic acid and shortage of ATP cause the muscles to lose their ability to contract, leading to fatigue.

(ix) Distinguish between the following:

(a) Difference between Axial skeleton and Appendicular skeleton.

- Axial skeleton forms the central axis of the body. It includes the skull, vertebral column, and rib cage, and its main function is to protect vital organs like the brain and heart.

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- Appendicular skeleton consists of the limbs and their girdles, such as pectoral and pelvic girdles. It helps in movement and locomotion.

(b) Difference between Phototactic and Chemotactic stimulus.

- **Phototactic** stimulus is the movement of an organism in response to light. For example, Euglena moves toward light for photosynthesis.
- **Chemotactic** stimulus is the movement in response to a chemical substance. For example, sperm cells move toward chemicals released by the ovum.

(c) Difference between Osteocytes and Osteoblast

- **Osteocytes** are mature bone cells that maintain bone tissue and are found within the bone matrix.
- **Osteoblasts** are bone-forming cells that secrete bone matrix and help in the growth and repair of bones.

(d) Difference between Brachialis and Brachioradialis.

- **Brachialis** is a muscle that lies under the biceps and helps in bending (flexing) the elbow.
- **Brachioradialis** is a muscle of the forearm that also helps in flexing the elbow and is located on the lateral side of the arm.

(e) Difference between Origin and Insertion of muscles.

- The **origin** of a muscle is the fixed end that does not move during contraction.
- The **insertion** of a muscle is the movable end that moves when the muscle contracts.

(f) Difference between Bone and Cartilage.

- **Bone** is a hard and rigid connective tissue containing calcium and phosphate salts. It provides support and forms the skeleton of the body.
- **Cartilage** is a flexible connective tissue made of chondrin. It is found in the nose, ear, and at the ends of bones to reduce friction.

(g) Difference between Troponin and Tropomyosin.

- **Troponin** is a protein complex attached to actin filaments. It binds with calcium ions to start muscle contraction.
- **Tropomyosin** is a fibrous protein that lies along the actin filaments and covers the binding sites when the muscle is relaxed.

Important Short Questions:

1. What is the main difference between plants and animals?

Answer:

Animals show locomotion and can move from one place to another, while plants are fixed and do not show movement.

2. Which cells provide support in young and adult plants?

Answer:

Collenchyma cells support young plants, while sclerenchyma cells provide strength to adult plants.

3. What is turgor pressure?

Answer:

Turgor pressure is the internal pressure of water inside plant cells that keeps the cells rigid and prevents wilting.

4. What is the role of parenchyma cells in support?

Answer:

Parenchyma cells absorb water by osmosis and maintain turgor pressure, providing internal support to soft plant parts.

5. What is lignin?**Answer:**

Lignin is a hard organic substance found in sclerenchyma cell walls that provides rigidity and strength to plants.

6. What are the three types of sclerenchyma cells?**Answer:**

The three types are Fibres (Tracheids), Sclereids, and Vessels (Tracheae).

7. What is secondary growth?**Answer:**

Secondary growth is the increase in thickness of stem and root due to cell division in vascular cambium and cork cambium.

8. What are sapwood and heartwood?**Answer:**

Sapwood is the outer active part of xylem that conducts water, while heartwood is the inner inactive part that provides strength.

9. What is the function of vascular bundles in stem?**Answer:**

Vascular bundles act like steel rods in concrete, providing strength and resistance against bending caused by wind.

10. What is the function of vascular cambium?

Answer:

Vascular cambium produces secondary xylem (inside) and secondary phloem (outside), increasing stem thickness.

11. What are the two main types of movements in plants?

Answer:

Movements in plants are of two types:

- (i) Autonomic movements – caused by internal factors.
- (ii) Paratonic movements – caused by external stimuli.

12. What is the difference between tactic and tropic movements?

Answer:

- Tactic movement involves the movement of the entire cell or organism (e.g. sperms moving towards archegonia),
- while tropic movement involves the bending or curvature of a plant part (e.g. bending of stem towards light).

13. What are turgor movements? Give one example.

Answer:

- Turgor movements are caused by gain or loss of water in plant cells.
- **Example:** Folding of leaves in *Mimosa pudica* (Touch-me-not plant).

14. Define phototropism and give one example.

Answer:

- Phototropism is the movement or growth of a plant part in response to light.
- **Example:** Bending of stem towards light (positive phototropism).

15. What is nutation?

Answer:

Nutation is the zig-zag movement of the growing tip of a young stem due to unequal growth on opposite sides of the apex.

16. What is the role of auxin in plant movements?

Answer:

Auxin controls phototropism and geotropism by causing unequal cell elongation, which results in bending of plant parts.

17. What is an exoskeleton? Give one example.

Answer:

- Exoskeleton is a hard outer covering that provides protection and support.
- **Example:** Shell of molluscs or chitinous covering of arthropods.

18. What is ecdysis or moulting?

Answer:

- Ecdysis (moulting) is the process of shedding the old exoskeleton and forming a new one for growth in arthropods.
- It is controlled by the hormone ecdysone.

19. What are the main functions of the skeletal system?

Answer:

Main functions of the skeletal system are:

- (i) Support and shape
- (ii) Protection of organs
- (iii) Movement
- (iv) Mineral storage
- (v) Blood cell formation

20. What is the difference between bone and cartilage?**Answer:**

- **Bone:** Hard connective tissue with calcium phosphate deposits.
- **Cartilage:** Soft, flexible tissue without blood vessels, made of collagen fibers.

21. What are the three types of muscles found in vertebrates?**Answer:****The three types of muscles are:**

- (i) Smooth muscles
- (ii) Cardiac muscles
- (iii) Skeletal muscles

22. What are smooth muscles and where are they found?**Answer:**

- Smooth muscles are non-striated and involuntary muscles with spindle-shaped cells containing a single nucleus.
- They are found in blood vessels, digestive tract, and internal organs.

23. What are cardiac muscles?

Answer:

- Cardiac muscles are striated, involuntary muscles found in the heart walls.
- They are branched and interconnected, forming a network for rhythmic contraction.

24. What are skeletal muscles?

Answer:

- Skeletal muscles are voluntary and striated muscles attached to bones by tendons.
- They help in movement of body parts, e.g., biceps and triceps.

25. What is a sarcomere?

Answer:

- A sarcomere is the region of a myofibril between two successive Z-lines.
- It is the smallest contractile unit of muscle fibre.

26. Name the two main types of myofilaments.

Answer:

The two main types of myofilaments are:

- (i) Thick filaments – made of myosin
- (ii) Thin filaments – made of actin, tropomyosin, and troponin

27. What is the sliding filament model of muscle contraction?

Answer:

- According to the sliding filament model, thin filaments slide over thick filaments, bringing Z-lines closer.
- As a result, the I-band shortens and the H-zone disappears, causing contraction.

28. What is the role of calcium ions (Ca⁺⁺) in muscle contraction?

Answer:

- Calcium ions bind with troponin, causing tropomyosin to move and expose binding sites on actin.
- This allows myosin heads to attach and initiate contraction.

29. Why does rigor mortis occur after death?

Answer:

- After death, ATP production stops, preventing the separation of actin and myosin.
- As a result, muscles become stiff, a condition called rigor mortis.

30. What is meant by “all or none response” in muscle contraction?

Answer:

- “All or none response” means that a muscle fibre either contracts completely or does not contract at all.
- The strength of contraction depends on the number of fibres involved.

31. What is the main source of energy for muscle contraction?

Answer:

The main source of energy for muscle contraction is ATP, which is produced by the aerobic breakdown of glucose in muscle cells.

32. What is the role of creatine phosphate in muscles?**Answer:**

Creatine phosphate provides extra energy when muscles require more ATP during high metabolism or strenuous activity.

33. How is ATP produced when oxygen is not available?**Answer:**

When oxygen is deficient, ATP is produced through anaerobic breakdown of glucose, resulting in the formation of lactic acid.

34. What causes muscle fatigue?**Answer:**

Muscle fatigue occurs due to ATP deficiency, accumulation of lactic acid, and ionic imbalance in muscle cells.

35. What is the fate of lactic acid after muscular activity?**Answer:**

At rest, 1/5 of lactic acid is broken down aerobically to release energy, which is used to convert the remaining 4/5 into glucose.

36. What is rigor mortis?**Answer:**

Rigor mortis is the stiffness of muscles after death caused by the absence of ATP, preventing the detachment of actin and myosin filaments.

37. What is tetany and its cause?**Answer:**

Tetany is a disease caused by low calcium levels in the blood, resulting in muscle twitches, spasms, and convulsions.

38. What is a muscle cramp?

Answer:

A muscle cramp is a tetanic contraction of a whole muscle that lasts for seconds or hours, causing pain and stiffness.

39. What are the three main parts of skeletal muscle?

Answer:

The three parts of skeletal muscle are:

- (i) Origin – fixed end
- (ii) Insertion – movable end
- (iii) Belly – thick, contractile middle part

40. What is the difference between tendons and ligaments?

Answer:

Tendons attach muscles to bones and are non-elastic, while ligaments attach bone to bone and are slightly elastic.

41. What is meant by antagonistic muscles?

Answer:

Antagonistic muscles are pairs of muscles that work against each other to move a joint, such as biceps and triceps at the elbow.

42. How does Euglena move?

Answer:

Euglena moves by the whipping action of a flagellum and also shows Euglenoid movement by contracting its body.

43. What is the mode of locomotion in Paramecium?

Answer:

Paramecium moves by ciliary movement, where cilia beat in a wave-like manner to propel the body forward.

44. How does earthworm move?

Answer:

Earthworm moves by the alternate contraction of circular and longitudinal muscles with the help of setae that anchor it to the ground.

45. What adaptations help birds in flight?

Answer:

Birds have lightweight bones, strong pectoral muscles, a keeled sternum, feathers, and a streamlined body – all adapted for efficient flight.

Q.5. Exercise Long Questions:

★ Q1: What are the disadvantages of exoskeleton?

❖ Answer:

- An exoskeleton is a hard external covering found in many invertebrates such as arthropods and molluscs. It provides protection, support, and surface for muscle attachment.
- However, it also has several disadvantages that affect the organism's growth and flexibility.

1. Limited Growth

- The exoskeleton does not grow along with the animal.
- Therefore, the organism must shed (moult) its exoskeleton from time to time to form a new, larger one.
- This process of shedding is called ecdysis or moulting, and it is risky because the animal becomes soft and defenseless during this period.

2. Heavy and Rigid Structure

- The exoskeleton is made of chitin or calcium carbonate, making it hard and heavy.
- This reduces mobility and limits the size of the organism.
- For this reason, animals with exoskeletons (like insects and crabs) are usually small in size.

3. Vulnerability During Moulting

- During moulting, the new exoskeleton is soft, and the animal remains vulnerable to predators and dehydration until it hardens.
- This is one of the most dangerous times in an arthropod's life cycle.

4. Limits Gas Exchange

- In many animals, the hard outer covering prevents free gas exchange through the skin.
- Therefore, they require special respiratory structures like tracheae or gills.

5. Restricts Growth and Body Expansion

- Because the exoskeleton is rigid, it prevents internal organs from expanding freely.
- It limits body flexibility and makes movement less efficient compared to animals with endoskeletons.

❖ Summary:

- The exoskeleton, though protective, causes major problems such as restricted growth, limited flexibility, danger during moulting, and difficulty in gas exchange.
- Hence, it is a disadvantageous structure for continuous growth and large body size.

🌟 Q2: What is the Sliding Filament Model? What does it explain?

❖ Answer:

- The Sliding Filament Model is the most accepted explanation of how muscles contract to produce movement.
- It was proposed by Huxley and Niedergerke (1954) and later supported by experimental evidence.

1. Structure of Myofibril

Each muscle fiber contains myofibrils, which are made up of two types of protein filaments:

- Actin (thin filament)
- Myosin (thick filament)

These filaments are arranged in repeating units called sarcomeres, which are the basic functional units of muscle contraction.

2. Main Idea of the Model

According to the Sliding Filament Model:

👉 Muscle contraction occurs when actin filaments slide over myosin filaments, making the sarcomere shorter without changing the length of the filaments themselves.

3. Step-by-Step Mechanism

(a) Attachment of Cross-Bridges:

- The myosin heads form cross-bridges by attaching to specific sites on the actin filaments.

(b) Power Stroke:

- The myosin heads bend, pulling the actin filaments toward the center of the sarcomere (H-zone).
- This causes the sarcomere to shorten, leading to contraction.

(c) Detachment:

- ATP binds to the myosin head, causing it to detach from the actin filament.

(d) Re-cocking of Myosin Head:

- The breakdown of ATP into ADP + Pi releases energy.
- This energy resets (re-cocks) the myosin head into its original position, ready for another cycle.

4. Role of Calcium Ions and ATP

- Calcium ions (Ca^{2+}) are released from the sarcoplasmic reticulum when a muscle fiber is stimulated.
- Calcium binds to troponin, causing tropomyosin to shift and expose binding sites on actin.
- ATP provides the energy for both cross-bridge movement and detachment.

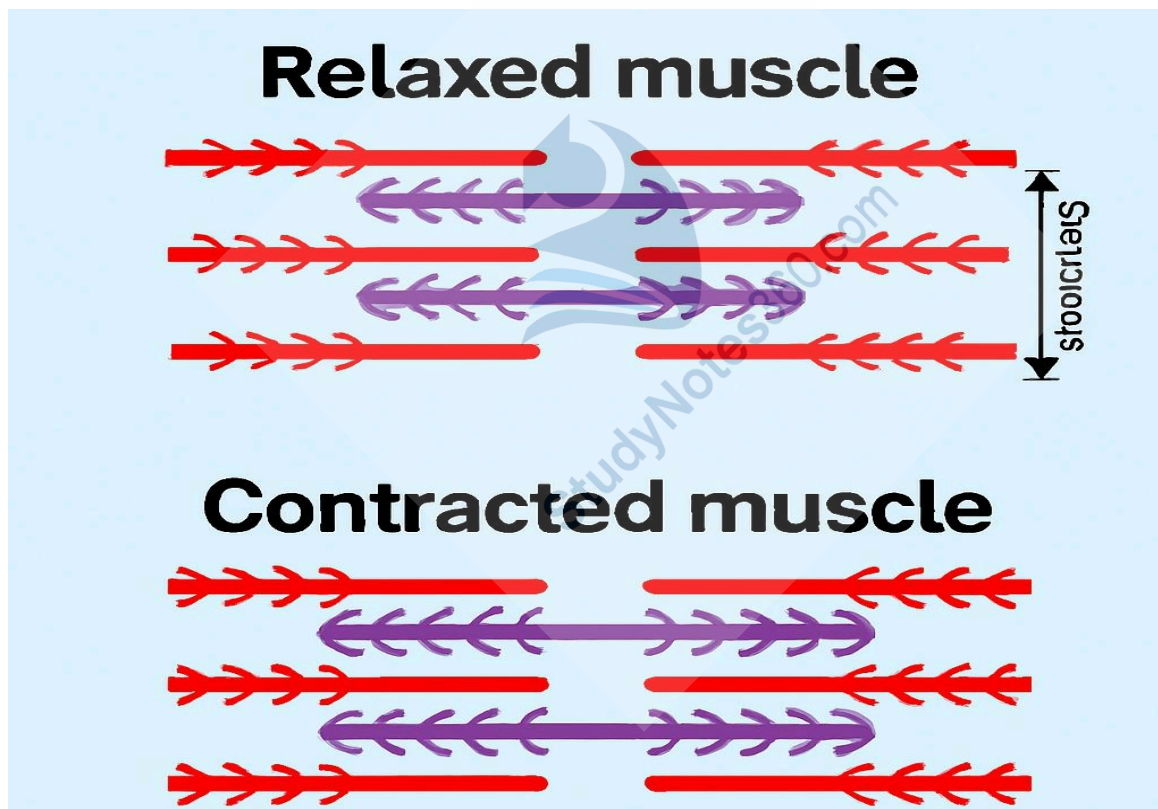
5. Result

- The repeated sliding of filaments shortens the sarcomeres, causing the entire muscle to contract and generate force.

6. What Does It Explain?

The Sliding Filament Model explains:

- How muscle shortening (contraction) occurs.
- The role of actin, myosin, calcium, and ATP in muscle contraction.
- Why muscles do not actually shorten their filaments, but slide them past each other.



❖ Summary:

The Sliding Filament Model describes that muscle contraction occurs due to the sliding of actin over myosin filaments powered by ATP and calcium ions, resulting in sarcomere shortening and movement production.

☀ **Q3: Describe a hinge joint and explain how it is moved by antagonistic muscles.**

❖ **Answer:**

A hinge joint is a type of synovial joint that allows movement in only one plane – like the opening and closing of a door. It is found in elbow, knee, and finger joints.

1. Structure of Hinge Joint

- The hinge joint is formed where the rounded end of one bone fits into the concave surface of another bone.
- It is enclosed in a capsule filled with synovial fluid, which lubricates the joint and reduces friction.
- Ligaments hold the bones together and prevent dislocation.

📌 **Examples:**

- Elbow joint (between humerus and ulna)
- Knee joint (between femur and tibia)
- Joints of fingers and toes

2. Movement of Hinge Joint

- The hinge joint allows flexion (bending) and extension (straightening).
- Movement occurs in a single direction, like a door hinge.

3. Antagonistic Muscles

- Muscles work in pairs called antagonistic muscles – one muscle contracts while the other relaxes.
- This coordination allows smooth and controlled movement.

4. Example – Movement at the Elbow Joint

At the elbow, the two main antagonistic muscles are:

- Biceps (flexor muscle)
- Triceps (extensor muscle)

When bending the arm (Flexion):

- Biceps contract to pull the forearm upward.
- Triceps relax to allow the movement.

When straightening the arm (Extension):

- Triceps contract to pull the forearm downward.
- Biceps relax to allow the movement.

5. Importance of Antagonistic Muscles

- Prevents overextension or damage to joints.
- Provides smooth, controlled, and reversible motion.
- Maintains body posture and coordination.

❖ Summary:

A hinge joint allows movement in one direction only. It is controlled by antagonistic muscles such as biceps and triceps that contract and relax alternately to produce flexion and extension at the joint.

★ **Q4: Define joints. How are they classified? Explain.**

❖ Answer:

- A joint is a place where two or more bones meet.
- Joints allow movement, support, and flexibility in the body. They also help in transmitting force from muscles to bones.

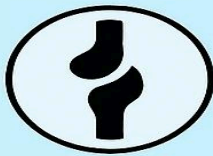
Joint are where two bones meet

Classified:



Immovable

Joints that
do not move



**Slightly
movable**

Joints that
move a little



**Freely
movable**

Joints that
move easily

1. Definition

> "A joint is the point of connection between two bones or between bone and cartilage."

2. Classification of Joints

Joints are classified on the basis of structure and movement into three main types:

(a) Immovable Joints (Fibrous Joints):

- These joints do not allow any movement.
- Bones are held tightly together by fibrous connective tissue.
- There is no joint cavity.

📌 **Examples:**

- Sutures of skull
- Teeth in jaw sockets

(b) Slightly Movable Joints (Cartilaginous Joints):

- These joints allow limited movement.
- Bones are joined by cartilage, which provides strength and flexibility.

📌 Examples:

- Joints between vertebrae of the spine
- Junction between ribs and sternum

(c) Freely Movable Joints (Synovial Joints)

- These joints allow free movement in one or more directions.
- Bones are separated by a synovial cavity filled with synovial fluid for lubrication.
- Ligaments and muscles support and strengthen the joint.

📌 Examples and Types of Synovial Joints:

1. Ball and socket joint – Shoulder, hip
2. Hinge joint – Elbow, knee
3. Pivot joint – Neck (atlas and axis)
4. Gliding joint – Wrist and ankle
5. Saddle joint – Thumb joint
6. Condyloid joint – Wrist

3. Importance of Joints

- Allow movement and flexibility
- Provide mechanical support

-
- Maintain body posture
 - Help in locomotion and daily activities

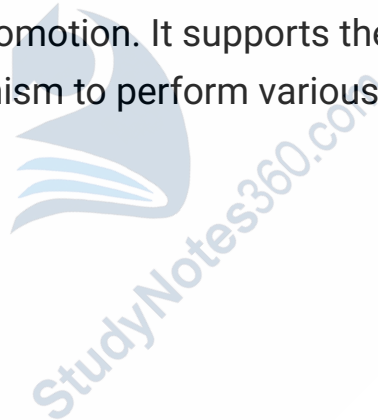
◆ **Summary:**

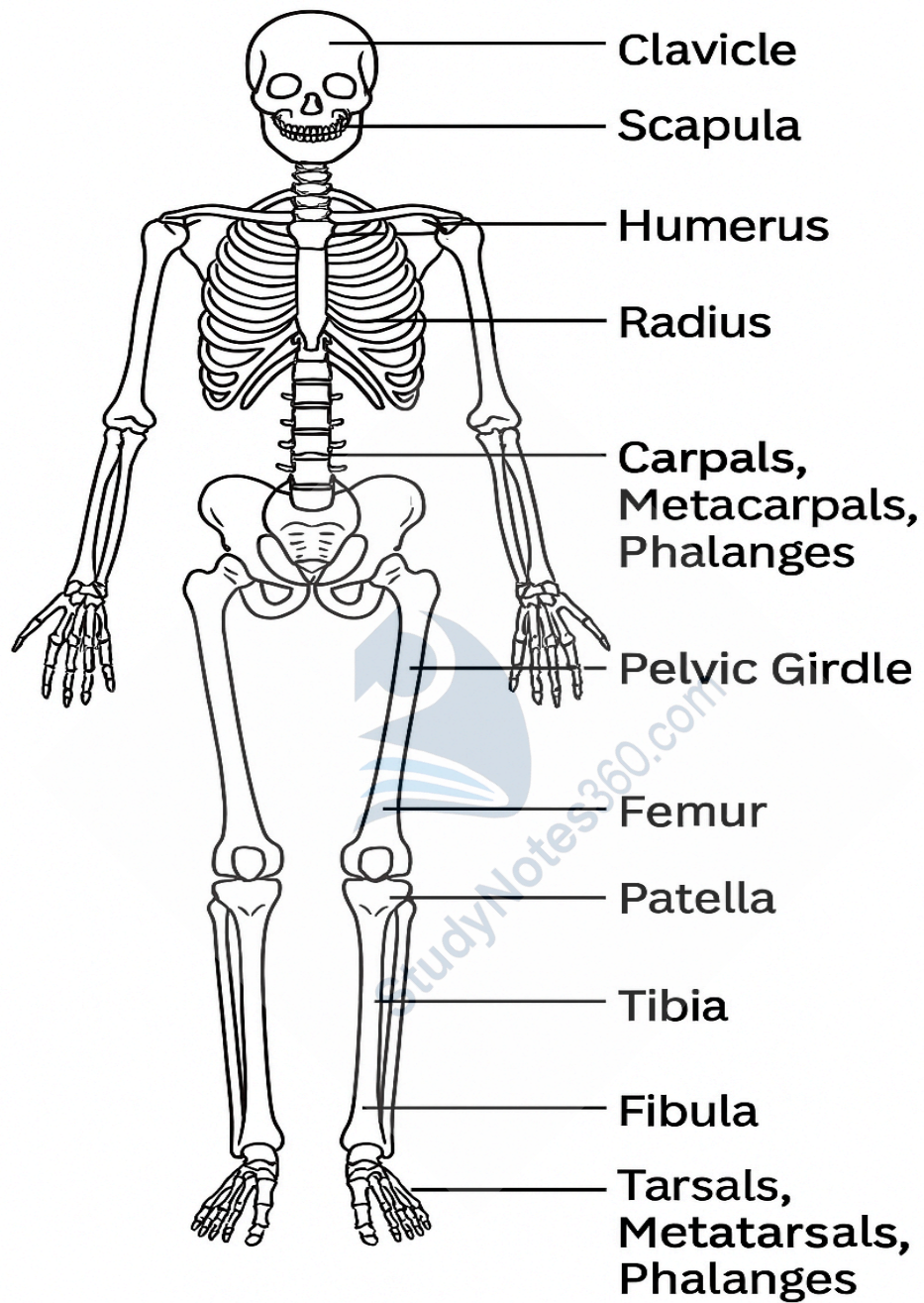
A joint is a meeting point of two bones. Based on movement, joints are classified into immovable, slightly movable, and freely movable types. Freely movable joints like synovial joints are the most common and allow wide range of movements.

✦ **Q5: Explain Appendicular Skeleton with the help of a diagram.**

❖ **Answer:**

The appendicular skeleton forms the framework of the limbs and girdles that help in movement and locomotion. It supports the body, maintains posture, and enables the organism to perform various physical activities.





1. Definition

> “The appendicular skeleton consists of the bones of limbs (arms and legs) and the girdles (shoulder and hip bones) that connect them to the axial skeleton.”

2. Main Divisions of Appendicular Skeleton

- The appendicular skeleton has two girdles and four limbs.

(a) Pectoral Girdle (Shoulder Girdle):

- It connects the upper limbs to the axial skeleton.

Each side has two bones:

1. Clavicle (collar bone)
2. Scapula (shoulder blade)

Function: It provides attachment for muscles and allows free movement of arms in various directions.

(b) Upper Limbs (Forelimbs):

Each upper limb has 30 bones arranged as follows:

- Humerus – single bone in upper arm
- Radius and Ulna – two bones in forearm
- Carpals – 8 wrist bones
- Metacarpals – 5 palm bones
- Phalanges – 14 finger bones

👉 Total bones per arm = 30

(c) Pelvic Girdle (Hip Girdle):

- It connects the lower limbs to the axial skeleton.

Made of two hip bones (coxal bones), each formed by:

- Ilium
- Ischium
- Pubis

Function: Supports body weight, protects pelvic organs, and provides attachment for lower limbs.

(d) Lower Limbs (Hind Limbs):

Each lower limb also has 30 bones, including:

- Femur – thigh bone (longest bone in body)
- Patella – kneecap
- Tibia and Fibula – bones of the leg
- Tarsals – 7 ankle bones
- Metatarsals – 5 bones of foot
- Phalanges – 14 toe bones

👉 Total bones per leg = 30

3. Functions of Appendicular Skeleton

- ✓ Provides movement and locomotion
- ✓ Maintains balance and posture
- ✓ Protects vital organs
- ✓ Provides attachment points for muscles
- ✓ Supports the weight of the body

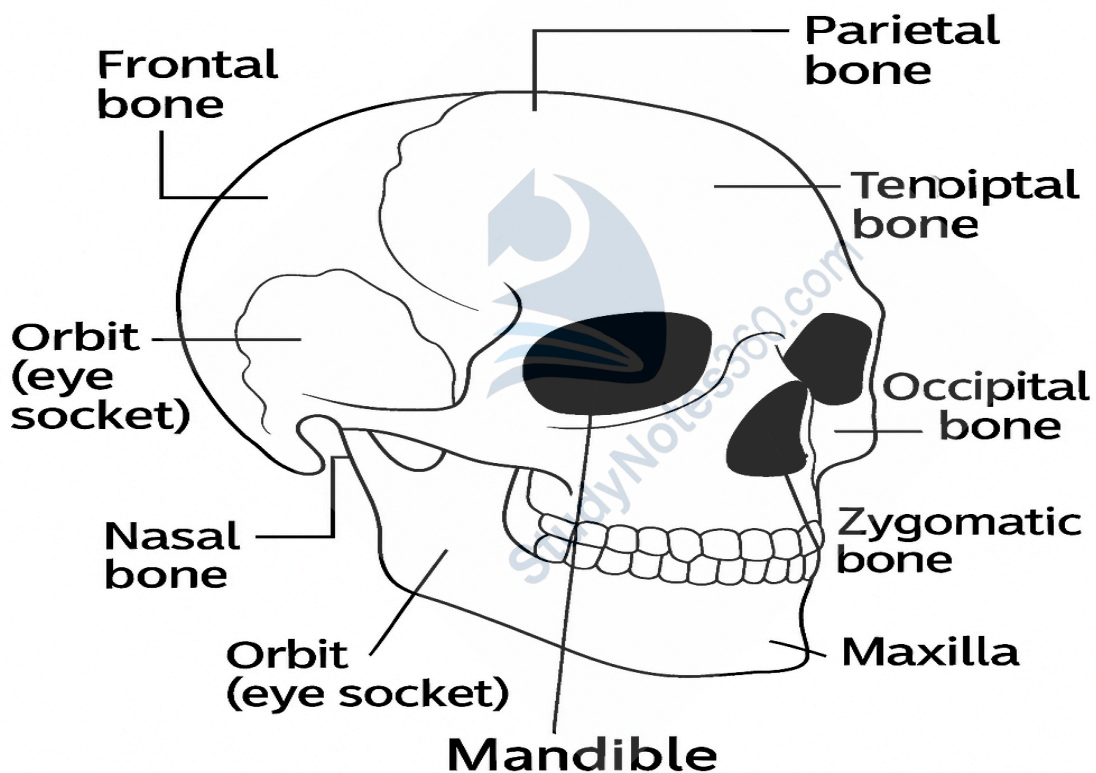
◆ Summary:

The appendicular skeleton includes all bones of limbs and girdles that attach to the axial skeleton. It provides mobility, balance, and support, making movement possible.

☀ Q6: Draw and Label the Human Skull.

❖ Answer:

The human skull is a strong bony structure that forms the framework of the head. It protects the brain, supports the sense organs, and provides attachment to muscles of the head and neck.



1. Composition

The skull is made up of 22 bones, grouped into two main parts:

(a) Cranium (Brain Box)

- Made up of 8 bones that enclose and protect the brain.

Main bones include:

- Frontal bone (forehead)
- Parietal bones (2)
- Temporal bones (2)
- Occipital bone
- Sphenoid bone
- Ethmoid bone

(b) Facial Bones

- Made up of 14 bones forming the face and jaws.

Main bones include:

- Nasal bones
- Zygomatic bones (cheek bones)
- Maxilla (upper jaw)
- Mandible (lower jaw – the only movable skull bone)
- Lacrimal bones
- Palatine bones
- Vomer

2. Functions of Skull

- ✓ Protects the brain from injury
- ✓ Provides attachment for head and facial muscles
- ✓ Supports eyes, ears, nose, and mouth
- ✓ Forms structure and shape of the head and face

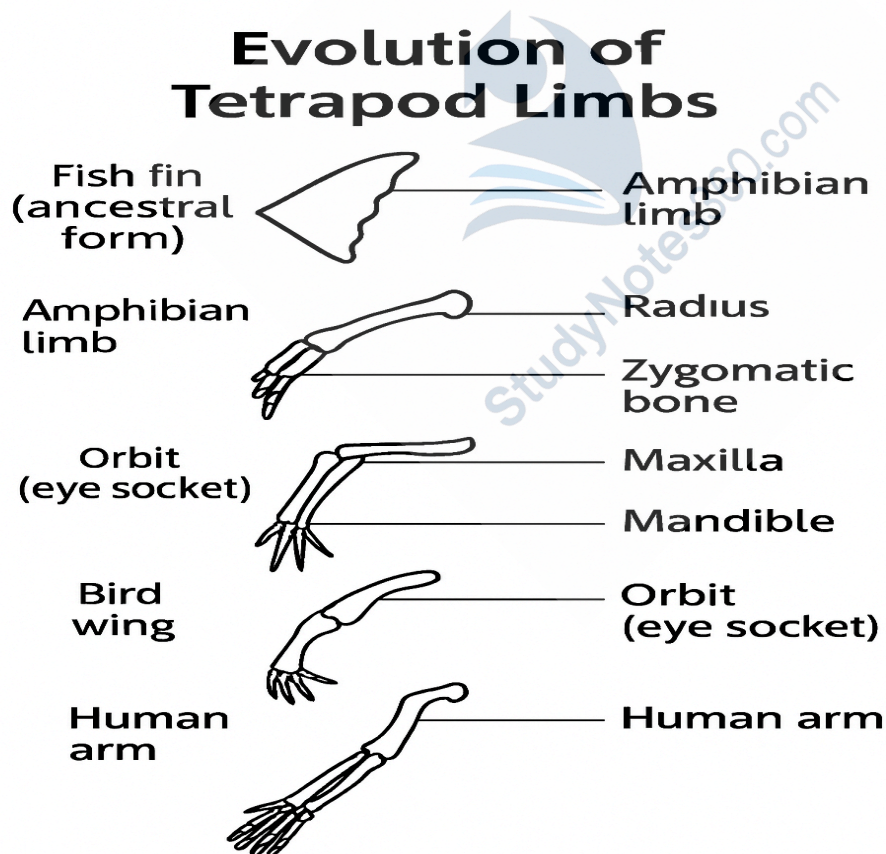
◆ **Summary:**

The human skull is composed of 22 bones (8 cranial + 14 facial). It provides protection, support, and structure to the head and face, and safeguards vital sensory organs.

✨ **Q7: Write the major evolutionary adaptations in the limbs of tetrapods.**

❖ **Answer:**

Introduction: Tetrapods are four-limbed vertebrates that evolved from lobe-finned fishes. Their limbs show gradual evolutionary modifications according to their mode of life – from aquatic to terrestrial.



◆ **Major Evolutionary Adaptations in Limbs:**

1. From Fins to Limbs:

- Early fishes had fins supported by fin rays.
- These fins gradually evolved into jointed limbs with digits (fingers and toes) for movement on land.

2. Modification of Limb Bones:

- The basic pentadactyl limb pattern (five digits) appeared.

Limbs had the same general structure:

- 👉 Upper segment (Humerus / Femur)
- 👉 Middle segment (Radius & Ulna / Tibia & Fibula)
- 👉 Lower segment (Hand/Foot bones)

3. Amphibians:

- First tetrapods to live partly on land.
- Limbs became strong and jointed for walking and jumping.

4. Reptiles:

- Limbs became more robust and extended to the sides for crawling and support.

5. Birds:

- Forelimbs modified into wings for flight.
- Hindlimbs adapted for perching or walking.

6. Mammals:

Limbs adapted for various functions:

- Running (Horse)

- Swimming (Whale)
- Flying (Bat)
- Grasping (Human)

🌟 **Q8: Define secondary growth. Explain.**

❖ **Answer:**

Definition: Secondary growth is the increase in girth or thickness of the stem and root due to the activity of lateral meristems (vascular cambium and cork cambium).

It occurs mainly in dicotyledonous plants and gymnosperms, not in monocots.

Types of Meristems Involved:

1. Vascular Cambium:

- Forms secondary xylem (wood) on the inner side.
- Forms secondary phloem on the outer side.
- Increases the diameter of the stem.

2. Cork Cambium (Phellogen):

- Develops in the outer cortex.

Produces:

- Cork (phellem) on the outer side → protective layer.
- Secondary cortex (phelloderm) on the inner side.

Process of Secondary Growth:

1. Formation of Vascular Cambium:

- Arises between primary xylem and primary phloem.

2. Activity of Cambium:

- Cells divide continuously.
- Xylem cells are formed inside → hard and woody.
- Phloem cells are formed outside → soft and living.

3. Formation of Annual Rings:

- Each year, cambium forms new xylem → forms annual rings (used to determine plant age).

4. Formation of Bark:

- Cork cells become suberized and form protective bark.

Result of Secondary Growth:

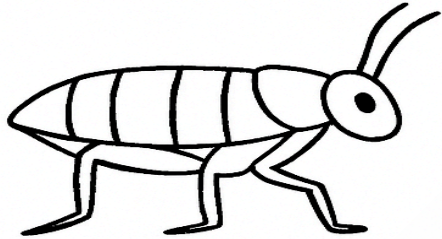
- Stem becomes thicker and stronger.
- Provides mechanical support for branches and leaves.
- Helps in transport of water and food over long distances.

★ Q9: What are the main differences between Exoskeleton and Endoskeleton?

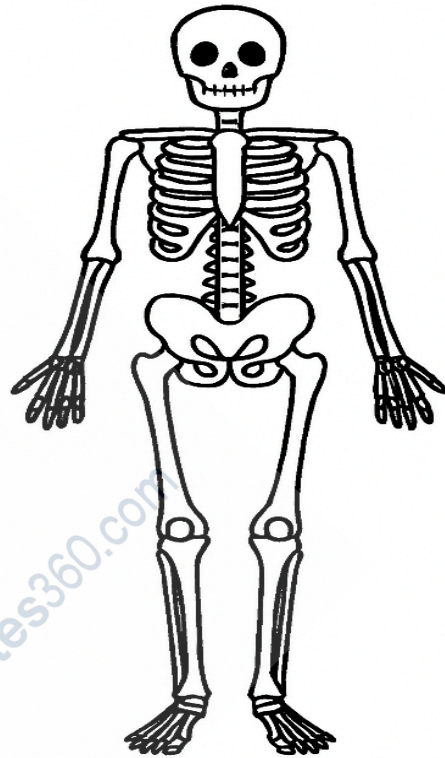
❖ Answer:

- The skeleton of animals exists in two main forms – Exoskeleton and Endoskeleton.
- Both provide support and protection but differ in their structure, position, and function.

Exoskeleton and Endoskeleton



Insect
showing outer
hard exoskeleton



Human skeleton
showing internal
bones and structure

Exoskeleton:

- The exoskeleton is the hard outer covering of the body found in many invertebrates.

- It is made up of chitin or calcium carbonate, which makes it tough and protective.
- It provides a rigid shield that protects internal organs and prevents the loss of body water.
- Exoskeleton also gives shape to the body and acts as a barrier against injury.
- However, it does not grow with the organism. To allow growth, animals must shed the old exoskeleton in a process called molting (or ecdysis).

Examples include insects, crabs, and mollusks.

Endoskeleton:

- The endoskeleton is the internal framework of bones and cartilage found inside the body.
- It is present in all vertebrates, such as fish, birds, reptiles, and humans.
- Unlike the exoskeleton, the endoskeleton grows along with the body, so there is no need for molting.
- It provides internal support, maintains body shape, and protects delicate organs like the brain, heart, and lungs.
- It also provides attachment sites for muscles, allowing movement of different body parts.

◆ **Summary:**

👉 The exoskeleton is external and non-living, providing protection but no growth flexibility.

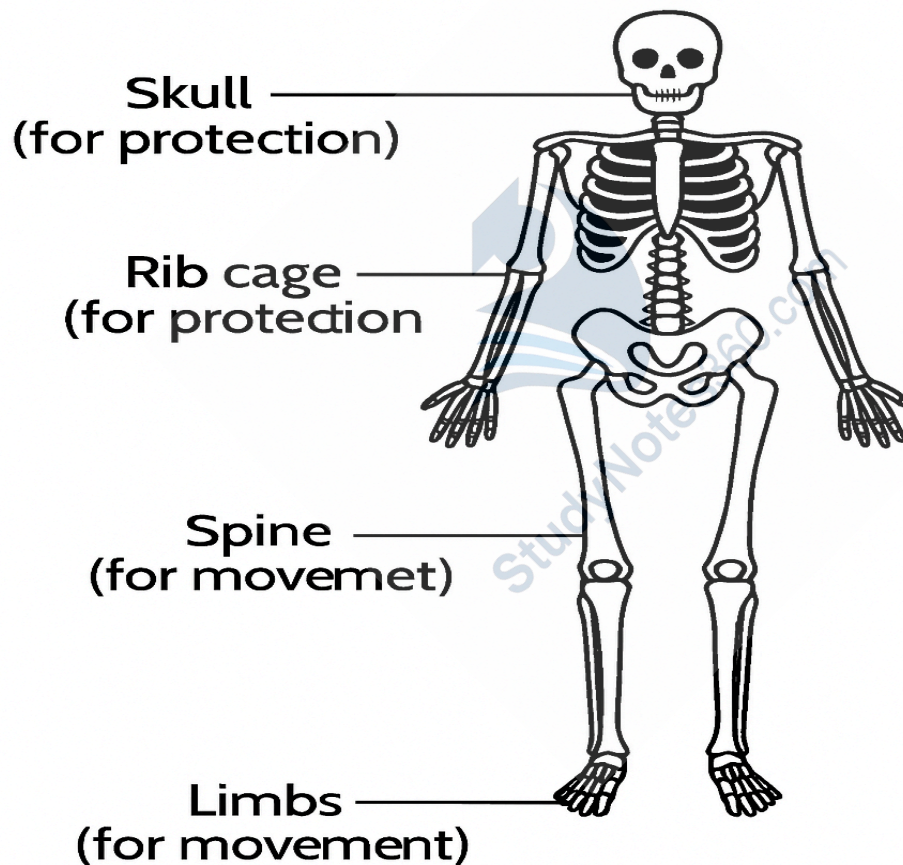
👉 The endoskeleton is internal and living, providing growth, support, and movement.

🌟 **Q10: List the functions of Skeleton.**

❖ **Answer:**

- The skeleton forms the main framework of the body in vertebrates.
- It not only supports the body but also performs many important biological functions.

Functions of Human Skeleton



 **1. Support:**

- The skeleton gives the body its proper shape and supports all soft tissues and organs.

- It acts as a rigid framework that maintains the posture of the body.

2. Protection:

Many bones of the skeleton protect vital internal organs.

For example:

- The skull protects the brain.
- The rib cage protects the heart and lungs.
- The vertebral column protects the spinal cord.

3. Movement:

- Bones and muscles work together to produce movement.
- Muscles are attached to bones, and when they contract, they pull on bones to move body parts.

4. Blood Cell Formation:

- Inside many bones, there is a soft tissue called bone marrow, which produces red blood cells, white blood cells, and platelets.

5. Mineral Storage:

- Bones act as a storehouse of minerals, especially calcium and phosphorus.
- These minerals can be released into the bloodstream whenever the body needs them.

6. Attachment of Muscles:

- Bones provide surfaces for the attachment of muscles, which makes movement possible.
- Without bones, muscles would have nothing to pull against.

7. Shape and Posture:

The skeleton maintains the overall shape and posture of the body, keeping internal organs in proper positions.

☀️ **Q11: Explain the role of osteoclasts in remodeling of bone and describe the structure of compact bone.**

❖ **Answer:**

- Bones are living, dynamic tissues that continuously undergo remodeling – the process of breaking down and rebuilding bone tissue.

Two main types of bone cells are involved in this process:

1. **osteoclasts**
2. **osteoblasts.**

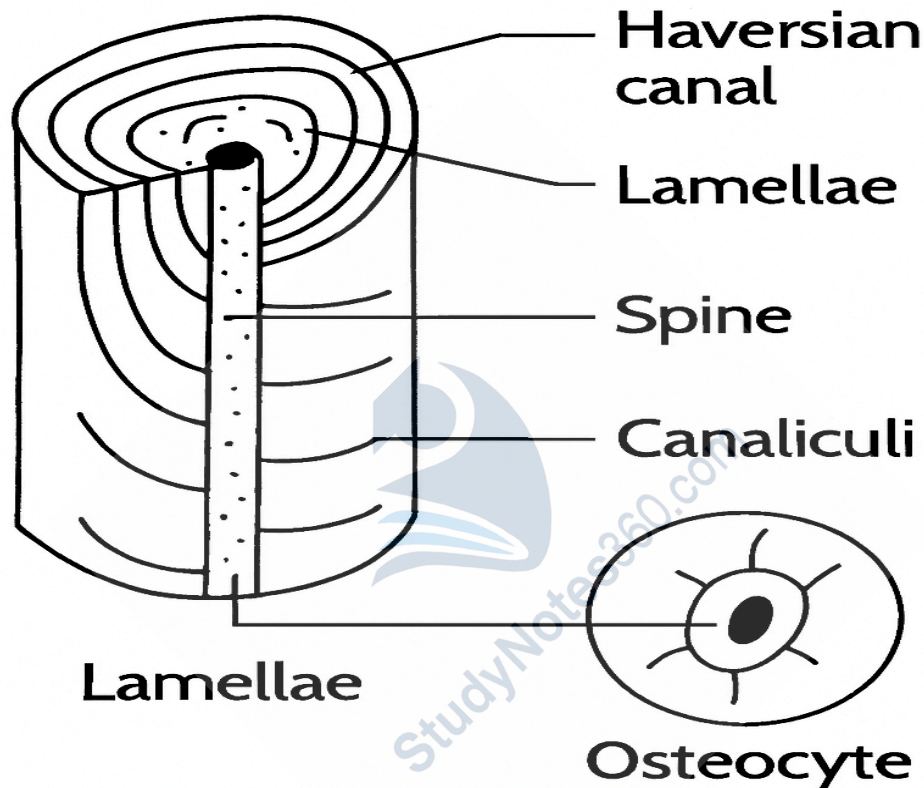
🧬 **Role of Osteoclasts in Bone Remodeling:**

- Osteoclasts are large, multinucleated cells that are responsible for the breakdown (resorption) of old or damaged bone tissue.
- They secrete enzymes and acids that dissolve the calcium phosphate matrix of the bone.
- This process releases calcium ions into the bloodstream, maintaining calcium balance in the body.
- Once the old bone is broken down, osteoblasts come in to deposit new bone material, thus maintaining the strength and shape of the bone.

🔴 **Summary Concept:**

👉 Osteoclasts destroy old bone, and osteoblasts build new bone – both working together to keep bones healthy and strong.

Structure of Compact Bone (Haversian System)



Structure of Compact Bone:

- Compact bone (also called dense bone) forms the outer hard layer of all bones and provides strength and protection.
- It is made up of a structural unit known as the Haversian System or Osteon.

Main Components of Compact Bone:

1. Osteon (Haversian System):

- Cylindrical units arranged parallel to the long axis of the bone.
- Each osteon consists of concentric rings (lamellae) of hard matrix surrounding a central canal.

2. Haversian Canal:

- A central tube in each osteon that contains blood vessels, lymph vessels, and nerves for nourishment and communication.

3. Lamellae:

- Circular layers of bone matrix surrounding the Haversian canal.
- Contain calcium salts and collagen fibers for strength.

4. Lacunae:

- Small spaces between lamellae that contain bone cells (osteocytes).

5. Canaliculi:

- Tiny canals that connect lacunae to each other and to the Haversian canal.
- Allow exchange of nutrients and wastes between osteocytes and blood vessels.

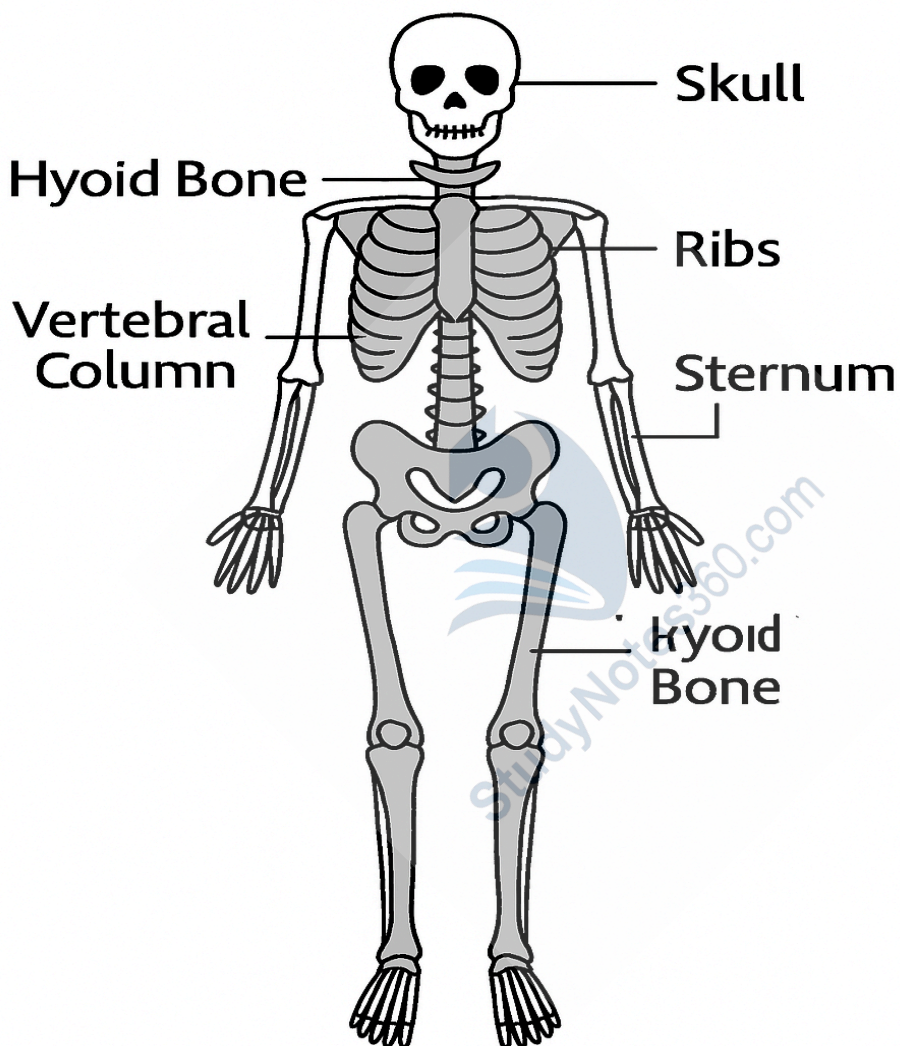
★ Q12: List the Main Parts of Axial Skeleton.

❖ Answer:

- The axial skeleton forms the central axis of the human body.
- It provides support, protection, and a framework for the body.
- It also serves as an attachment for muscles and helps in maintaining posture and balance.

- The axial skeleton consists of 80 bones that include the skull, vertebral column, thoracic cage, hyoid bone, and auditory ossicles.

Axial Skeleton



1. Skull (22 bones):

- The skull forms the head region and encloses the brain. It protects the brain and houses the organs of sight, hearing, smell, and taste.

It is made up of two main parts:

- **Cranial bones (8):** These form the braincase. Examples are frontal, parietal, temporal, occipital, sphenoid, and ethmoid bones.
- **Facial bones (14):** These form the structure of the face. Examples are maxilla, mandible, nasal, zygomatic, lacrimal, palatine, vomer, and inferior nasal conchae.
- The skull gives shape to the head and provides cavities for sense organs.

2. Vertebral Column (33 vertebrae):

- The vertebral column, or backbone, extends from the skull to the pelvis. It forms the main support for the body and protects the spinal cord.

It is divided into five regions:

1. Cervical vertebrae – 7 in number (neck region)
2. Thoracic vertebrae – 12 in number (attached to ribs)
3. Lumbar vertebrae – 5 in number (lower back)
4. Sacral vertebrae – 5 fused to form the sacrum
5. Coccygeal vertebrae – 4 fused to form the coccyx

The vertebral column supports the head, allows flexibility, and maintains body posture.

3. Thoracic Cage (Ribs and Sternum):

- The thoracic cage is made up of the sternum (breastbone) and 12 pairs of ribs.

- It forms a protective enclosure for the heart, lungs, and large blood vessels.
- The first seven pairs are called true ribs because they are directly attached to the sternum.
- The next three pairs are false ribs because they are indirectly attached to the sternum.
- The last two pairs are floating ribs because they are not attached to the sternum at all.
- The thoracic cage plays an important role in respiration, as it expands and contracts during breathing.

4. Hyoid Bone:

- The hyoid bone is a U-shaped bone located in the neck just below the mandible (lower jaw).
- It is unique because it does not join directly with any other bone.
- It provides attachment to the muscles of the tongue, pharynx, and larynx and assists in swallowing and speech.

5. Auditory Ossicles (6 small bones):

- These are the smallest bones in the human body, located in the middle ear – three in each ear.
- They are named malleus (hammer), incus (anvil), and stapes (stirrup).
- Their main function is to transmit sound vibrations from the eardrum to the inner ear, enabling hearing.

Functions of the Axial Skeleton:

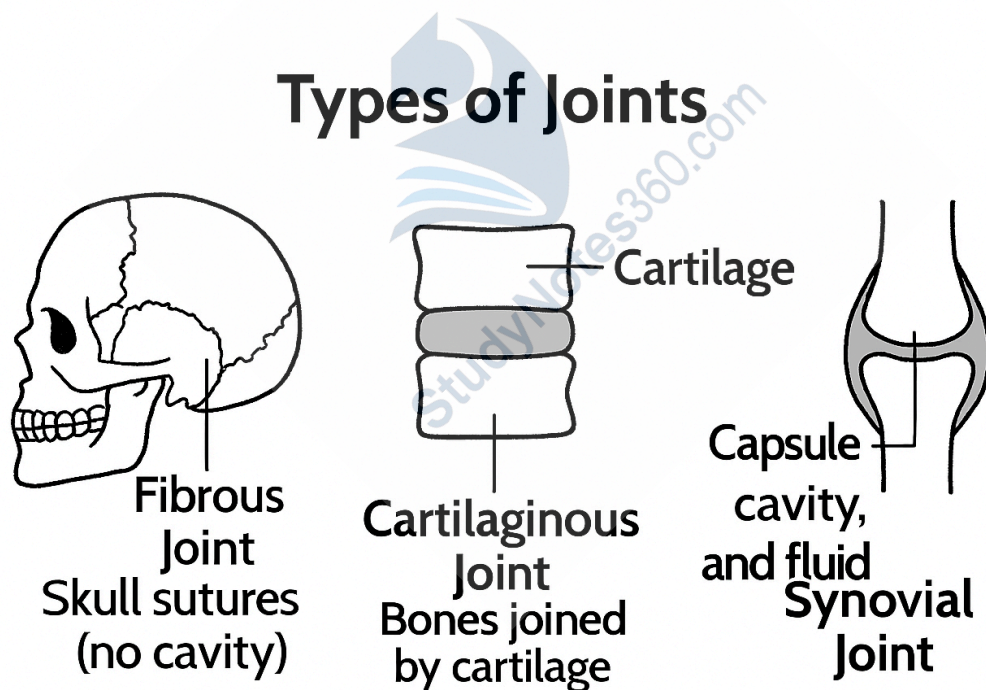
- It provides support to the head, neck, and trunk.
- It protects vital organs like the brain, spinal cord, heart, and lungs.
- It provides attachment sites for muscles involved in movement and posture.

- It helps maintain the upright posture of the body.
- It plays an important role in respiratory movement through the ribs and sternum.

☀ Q13: Distinguish Between Fibrous, Cartilaginous and Synovial Joints

❖ Answer:

- A joint is a point where two or more bones meet.
- It allows movement and provides flexibility and strength to the skeleton.
- Joints are classified based on the type of material that connects the bones and the degree of movement they allow.




1. Fibrous Joints (Immovable Joints):

- These joints have no joint cavity.

- The bones are tightly joined by fibrous connective tissue, allowing no movement.
- They are also called fixed or immovable joints.

Example:

- Sutures of the skull
- Joint between teeth and jawbone


 **Concept:** Fibrous joints provide strength and protection rather than movement.

2. Cartilaginous Joints (Slightly Movable Joints):

- The bones are connected by cartilage (a tough, flexible tissue).
- There is limited movement between bones.
- They act as shock absorbers and allow slight flexibility.

Example:

- Joints between vertebrae in the vertebral column
- Joint between ribs and sternum


 **Concept:** These joints are important where both strength and flexibility are needed, such as in the backbone.

3. Synovial Joints (Freely Movable Joints):

- These joints have a synovial cavity filled with synovial fluid.
- The fluid acts as a lubricant, reducing friction between bones.
- Ends of bones are covered with articular cartilage to prevent wear and tear.
- A joint capsule surrounds and protects the joint.

Example:

- Shoulder joint (ball and socket)
- Elbow and knee joint (hinge joints)

 **Concept:** Synovial joints are the most common and most movable joints in the body.

◆ **Summary:**

Fibrous joints are immovable, cartilaginous joints are slightly movable, while synovial joints are freely movable and contain synovial fluid for smooth motion.


★ **Q14: Discuss Methods of Locomotion in Fish, Land Vertebrates, and Birds**

❖ **Answer:**

- Locomotion means movement of the whole body from one place to another.
- In animals, locomotion is adapted to their habitat and mode of life.
- Vertebrates show different methods of locomotion depending on their environment – aquatic, terrestrial, or aerial.

1. Locomotion in Fish 

- Fish live in water and swim using their muscles, fins, and tail.
- Their body is streamlined (tapered at both ends) to reduce water resistance.
- The muscles of the body wall contract alternately on both sides, creating wave-like movements that push the fish forward.
- The caudal (tail) fin provides thrust and steering.
- The pectoral and pelvic fins help in balance, turning, and stopping.


 **Concept:** The swimming movement of fish is due to the contraction of myotomes (muscle blocks) and the use of fins for direction and stability.

2. Locomotion in Land Vertebrates:

- Land vertebrates include amphibians, reptiles, mammals, and humans.
- They move mainly by walking, running, crawling, or jumping.
- Movement is performed by the limbs, which are jointed and supported by the appendicular skeleton.
- The muscles contract and relax alternately to move the bones of the limbs.


Examples:

- Frogs use hind limbs for jumping.
- Reptiles like lizards crawl by lateral body movement.
- Mammals like humans walk or run using coordinated limb action.

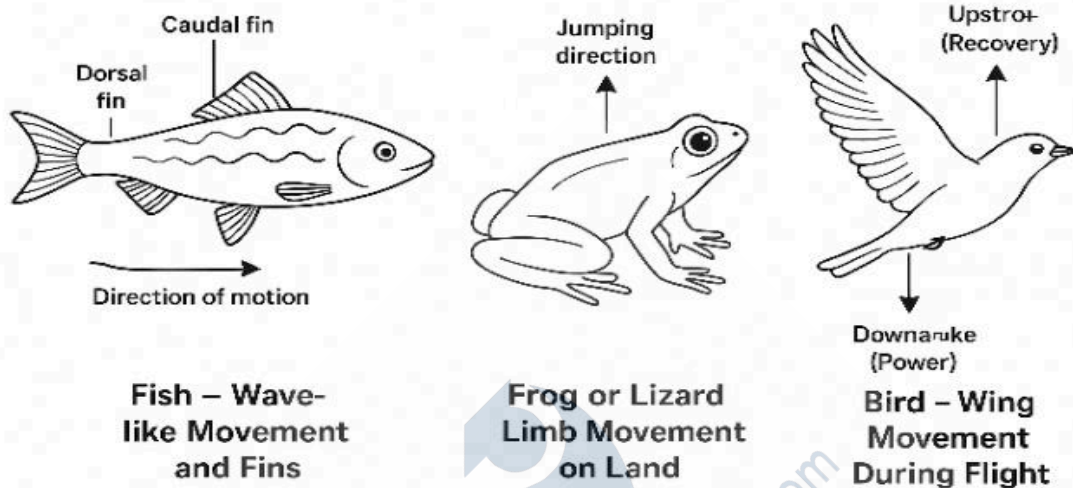
 **Concept:** Terrestrial locomotion depends on friction, gravity, and muscular coordination.

3. Locomotion in Birds:

- Birds are aerial vertebrates adapted for flight.
- Their bodies are streamlined to minimize air resistance.
- The forelimbs are modified into wings, and feathers help in lift and balance.
- The breast muscles (pectoralis major) are large and powerful – used to move wings during flight.
- Light bones (air-filled) reduce body weight.
- The tail feathers help in steering and braking.

 **Concept:** Flight in birds results from the downward stroke of wings and air pressure difference above and below the wings (Bernoulli's principle).

Methods of Locomotion in Vertebrates



◆ Summary:

- Fish use muscles and fins for swimming.
- Land vertebrates use limbs for walking, running, or jumping.
- Birds use wings, feathers, and flight muscles for flying.

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

Author: Muhammad Asghar

Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.

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