

BIOLOGY



PLANT



ANIMAL



CELL



CELL



DNA

Class: 11th

Subject: Biology

Chapter 12: HUMAN

SKELETAL & MUSCULAR

SYSTEMS

❖ Important MCQs:

1. The skeleton mainly functions to:

- (a) Produce hormones
- (b) Provide support and protection
- (c) Digest food
- (d) Transport oxygen

2. The framework formed by bones and cartilage is called:

- (a) Tissue system
- (b) Skeleton
- (c) Muscular system
- (d) Nervous system

3. Bones are primarily made of:

- (a) Muscle tissue
- (b) Connective tissue
- (c) Epithelial tissue
- (d) Nervous tissue

4. The outer membrane of bone is:

- (a) Cartilage
- (b) Periosteum

(c) Ligament

(d) Tendon

5. Compact bone is important because it:

(a) Stores fat

(b) Provides strength and hardness

(c) Produces blood

(d) Connects muscles

6. The structural unit of compact bone is:

(a) Sarcomere

(b) Haversian system

(c) Nephron

(d) Alveoli

7. Lamellae consist of:

(a) Blood cells

(b) Concentric layers of matrix

(c) Nerves

(d) Fat

8. Calcium phosphate crystals in bone are:

(a) Soft

(b) Flexible

(c) Brittle but strong

(d) Liquid

9. Collagen in bone makes it:

(a) Hard

(b) Flexible

(c) Heavy

(d) Dry

10. Lacunae are spaces that contain:

(a) Blood

(b) Osteocytes

(c) Fat

(d) Minerals

11. Osteocytes are:

(a) Immature cells

(b) Mature bone cells

(c) Blood cells

(d) Muscle cells

12. The Haversian canal contains:

(a) Air

(b) Blood vessels and nerves

(c) Fat

(d) Only minerals

13. Canaliculi help in:

(a) Movement

(b) Communication between osteocytes

(c) Digestion

(d) Breathing

14. Spongy bone is located:

(a) Outside bone

(b) Beneath compact bone

(c) In muscles

(d) In skin

15. Spongy bone structure is:

(a) Solid

(b) Lattice-like

(c) Liquid

(d) Smooth

16. Red bone marrow produces:

(a) Hormones

(b) Blood cells

(c) Fat

(d) Enzymes

17. Yellow bone marrow mainly contains:

(a) Blood

(b) Fat cells

(c) Water

(d) Minerals

18. Red bone marrow is found in:

(a) Shafts of long bones

(b) Ends of long bones and spongy bone

(c) Skin

(d) Muscles

19. Yellow marrow converts into red marrow during:

(a) Exercise

(b) Blood loss

(c) Sleep

(d) Digestion

20. Collagen fibres also help to:

(a) Break bone

(b) Anchor periosteum to bone

(c) Produce blood

(d) Store minerals

21. Osteoblasts are responsible for:

(a) Breaking bone

(b) Forming bone

(c) Storing fat

(d) Producing blood

22. Osteocytes are formed from:

(a) Osteoclasts

(b) Osteoblasts

(c) Chondrocytes

(d) Macrophages

23. The main function of osteocytes is to:

(a) Destroy bone

(b) Maintain bone tissue

(c) Store calcium

(d) Produce cartilage

24. Osteoclasts are involved in:

(a) Bone formation

(b) Bone maintenance

(c) Bone resorption

(d) Blood production

25. Osteoclasts develop from:

(a) Neurons

(b) Macrophages

(c) Osteoblasts

(d) Chondrocytes

26. Bone formation process is called:

(a) Calcification

(b) Osteogenesis

(c) Respiration

(d) Diffusion

27. In long bones, cartilage is replaced by bone through:

(a) Diffusion

(b) Ossification

(c) Respiration

(d) Filtration

28. During ossification, chondrocytes:

(a) Multiply rapidly

(b) Die and form cavities

(c) Turn into osteoclasts

(d) Produce blood

29. Blood vessels enter cartilage during bone formation to:

(a) Destroy tissue

(b) Bring osteoblasts and osteoclasts

(c) Remove oxygen

(d) Store fat

30. Some cartilage remains in the body mainly to:

(a) Increase weight

(b) Provide flexibility

(c) Store blood

(d) Produce energy

31. Cartilage is surrounded by:

(a) Periosteum

(b) Perichondrium

(c) Endosteum

(d) Ligament

32. Cartilage matrix contains:

(a) Only calcium

(b) Collagen and elastin

(c) Only water

(d) Blood cells

33. Cartilage heals slowly because:

(a) It has no cells

(b) It has no blood vessels

(c) It is very hard

(d) It lacks collagen

34. Cartilage cells are called:

(a) Osteocytes

(b) Chondrocytes

(c) Myocytes

(d) Neurons

35. Chondrocytes are located in:

(a) Canals

(b) Lacunae

(c) Matrix only

(d) Blood vessels

36. The most common type of cartilage is:

(a) Elastic cartilage

(b) Fibrocartilage

(c) Hyaline cartilage

(d) Calcified cartilage

37. Hyaline cartilage is found in:

(a) External ear

(b) Nose and trachea

(c) Intervertebral discs

(d) Skull

38. Fibrocartilage is present in:

(a) Nose

(b) Ear

(c) Intervertebral discs

(d) Trachea

39. Elastic cartilage is found in:

(a) Bones

(b) External ear

(c) Spine

(d) Ribs

40. The human skeleton consists of:

(a) 180 bones

(b) 196 bones

(c) 206 bones

(d) 210 bones

41. The skeleton is divided into:

(a) Two parts

(b) Three parts

(c) Four parts

(d) Five parts

42. The axial skeleton mainly protects:

(a) Limbs

(b) Organs of head, neck, and chest

(c) Muscles

(d) Skin

43. The skull consists of:

(a) 20 bones

(b) 22 bones

(c) 24 bones

(d) 26 bones

44. The number of cranial bones is:

(a) 6

(b) 8

(c) 10

(d) 12

45. The vertebral column consists of:

(a) 30 vertebrae

(b) 31 vertebrae

(c) 33 vertebrae

(d) 35 vertebrae

46. Appendicular skeleton includes:

(a) Skull and ribs

(b) Arms and legs

(c) Vertebral column

(d) Sternum

47. Pectoral girdle consists of:

(a) Femur and tibia

(b) Clavicle and scapula

(c) Radius and ulna

(d) Pelvis bones

48. The clavicle is also called:

(a) Shoulder bone

(b) Collar bone

(c) Hip bone

(d) Thigh bone

49. The number of bones in each forelimb is:

(a) 25

(b) 28

(c) 30

(d) 32

50. The bone that fits into the glenoid cavity is:

(a) Radius

(b) Ulna

(c) Humerus

(d) Femur

51. Radius is located on the:

(a) Inner side of arm

(b) Outer (thumb) side of arm

(c) Middle of arm

(d) Lower arm only

52. The wrist is formed by:

(a) Metacarpals

(b) Carpals

(c) Tarsals

(d) Phalanges

53. The pelvic girdle consists of:

(a) One bone

(b) Two hip bones

(c) Three bones

(d) Four bones

54. The socket in pelvic girdle is called:

(a) Glenoid cavity

(b) Acetabulum

(c) Lacuna

(d) Foramen

55. A joint is defined as:

(a) A muscle connection

(b) Place where two bones meet

(c) A nerve junction

(d) A blood vessel

56. Intervertebral discs mainly function as:

(a) Blood producers

(b) Shock absorbers

(c) Muscle connectors

(d) Ligaments

57. A slipped disc occurs when:

(a) Bone breaks

(b) Outer layer of disc tears and inner material leaks

(c) Cartilage hardens

(d) Ligaments stretch

58. A slipped disc may compress:

(a) Muscles

(b) Nerves or spinal cord

(c) Skin

(d) Blood cells

59. Spondylosis refers to degeneration of:

(a) Muscles only

(b) Vertebrae and intervertebral discs

(c) Skin

(d) Blood vessels

60. Spondylosis most commonly affects:

(a) Skull region

(b) Neck and lower back

(c) Arms only

(d) Legs only

61. Sciatica is caused by compression of the:

(a) Femoral nerve

(b) Sciatic nerve

(c) Optic nerve

(d) Radial nerve

62. The sciatic nerve runs from:

(a) Brain to arms

(b) Neck to shoulders

(c) Lower back to legs

(d) Chest to abdomen

63. Arthritis is a disorder of:

(a) Muscles

(b) Joints

(c) Skin

(d) Blood

64. Osteoarthritis affects mainly:

(a) Skin

(b) Articular cartilage of joints

(c) Blood vessels

(d) Nerves

65. Rheumatoid arthritis is caused by:

(a) Infection

(b) Autoimmune response

(c) Injury

(d) Lack of calcium

66. Osteoporosis is characterized by:

(a) Strong and dense bones

(b) Weak and porous bones

(c) Increased muscle mass

(d) Increased cartilage

67. Osteoporosis mainly occurs due to decrease in:

(a) Blood cells

(b) Bone density

(c) Muscle strength

(d) Nerve activity

68. A major cause of osteoporosis in women is:

(a) High protein intake

(b) Decrease in estrogen levels after menopause

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- (c) Excess exercise
 - (d) Increased calcium intake

69. Vitamin D is important because it helps in:

- (a) Producing blood cells
- (b) Absorbing calcium
- (c) Forming muscles
- (d) Breaking fats

70. Lack of which activity increases risk of osteoporosis?

- (a) Sleeping
- (b) Weight-bearing exercise
- (c) Reading
- (d) Breathing

71. A dislocation occurs when:

- (a) Bones fracture
- (b) Bones move out of their normal joint position
- (c) Muscles contract
- (d) Ligaments shrink

72. A common symptom of dislocation is:

- (a) Fever
- (b) Swelling and intense pain

(c) Cough

(d) Headache

73. A sprain is an injury to:

(a) Bones

(b) Ligaments

(c) Muscles

(d) Nerves

74. Sprains usually occur when a joint is:

(a) At rest

(b) Forced beyond its normal range of motion

(c) Immobile

(d) Frozen

75. First aid for dislocation includes:

(a) Moving the joint immediately

(b) Immobilizing the affected area

(c) Ignoring the injury

(d) Applying heat only

76. Muscle tissue is best defined as tissue that:

(a) Stores energy

(b) Contracts to produce movement

(c) Produces hormones

(d) Protects organs

77. The individual cells of muscle tissue are called:

(a) Neurons

(b) Osteocytes

(c) Muscle fibres (myofibres)

(d) Chondrocytes

78. Skeletal muscles are also known as voluntary muscles because they are:

(a) Involuntary in action

(b) Under conscious control

(c) Found in internal organs only

(d) Controlled by hormones only

79. Which type of muscle is found in the walls of the stomach and intestines?

(a) Skeletal muscle

(b) Cardiac muscle

(c) Smooth muscle

(d) Voluntary muscle

80. Smooth muscle fibres are characterized by:

(a) Striations and multiple nuclei

(b) Spindle shape and single nucleus

(c) Branched structure and striations

(d) Absence of nucleus

81. Cardiac muscle fibres are unique because they:

(a) Are non-striated

(b) Lack nuclei

(c) Are branched and striated with one nucleus

(d) Are spindle-shaped

82. Tendons are made up of:

(a) Nervous tissue

(b) Blood tissue

(c) Collagen and connective tissue

(d) Epithelial cells

83. The cell membrane of a muscle fibre is called:

(a) Sarcoplasm

(b) Sarcolemma

(c) Myofibril

(d) Endomysium

84. The cytoplasm of a muscle fibre is called:

(a) Sarcolemma

(b) Sarcoplasm

(c) Sarcomere

(d) Cytosol

85. Transverse tubules (T-tubules) are responsible for:

(a) Storing calcium

(b) Carrying impulses deep into the muscle fibre

(c) Producing proteins

(d) Forming myofibrils

86. Myofibrils are composed of:

(a) Bones and ligaments

(b) Actin and myosin filaments

(c) Nerves and blood vessels

(d) Cartilage and tendons

87. The dark bands in skeletal muscle are called:

(a) I-bands

(b) H-bands

(c) A-bands

(d) Z-lines

88. The light bands in skeletal muscle are called:

(a) A-bands

(b) I-bands

(c) M-lines

(d) Z-lines

89. The region between two Z-lines is known as:

(a) Myofibril

(b) Sarcomere

(c) Sarcolemma

(d) H-zone

90. During muscle contraction:

(a) A-bands shorten

(b) I-bands and H-bands decrease in size

(c) Z-lines disappear

(d) Myofibrils break apart

91. According to the sliding filament model, muscle contraction occurs when:

(a) Actin filaments shorten

(b) Myosin filaments shorten

(c) Thin filaments slide past thick filaments

(d) Both filaments disappear

92. In a relaxed muscle, myosin binding sites on actin are blocked by:

(a) Troponin

(b) Myosin

(c) Tropomyosin

(d) ATP

93. Calcium ions released from sarcoplasmic reticulum bind to:

(a) Myosin

(b) Actin

(c) Troponin

(d) Tropomyosin

94. The power stroke in muscle contraction is caused by:

(a) ATP binding to actin

(b) Myosin heads pulling actin filaments after releasing ADP and Pi

(c) Calcium entering nucleus

(d) Breakdown of actin filaments

95. After contraction, myosin heads detach from actin when:

(a) Calcium binds to actin

(b) ATP binds to myosin head

(c) ADP is released

(d) Tropomyosin blocks binding sites

96. Muscle fatigue is defined as:

(a) Increase in muscle strength

(b) Decline in muscle performance after prolonged activity

(c) Sudden muscle contraction

(d) Permanent muscle damage

97. One major cause of muscle fatigue is:

(a) Excess oxygen supply

(b) Depletion of ATP in muscles

(c) Increase in calcium ions

(d) Increase in blood flow

98. Accumulation of which substance contributes to muscle fatigue?

(a) Oxygen

(b) Glucose

(c) Lactate and hydrogen ions

(d) Water

99. Muscle cramps are best described as:

(a) Slow voluntary movements

(b) Sudden involuntary painful contractions

(c) Continuous relaxation of muscles

(d) Permanent paralysis

100. A common cause of muscle cramps is:

(a) High protein diet

(b) Dehydration and electrolyte imbalance

(c) Excess oxygen supply

(d) Strong bones

101. Tetany is mainly caused by:

(a) High blood sugar

(b) Hypocalcaemia (low calcium levels)

(c) Excess iron

(d) High blood pressure

102. Tetany involves:

(a) Weak muscle relaxation only

(b) Involuntary muscle spasms due to nerve hyperexcitability

(c) Bone fracture

(d) Muscle growth

103. Which condition is caused by a bacterial infection?

(a) Tetany

(b) Muscle fatigue

(c) Tetanus

(d) Muscle cramps

104. Tetanus mainly affects which muscles?

(a) Leg muscles only

(b) Jaw and neck muscles

- (c) Arm muscles only
- (d) Heart muscles

105. The most serious condition among the following is:

- (a) Muscle cramps
- (b) Muscle fatigue
- (c) Tetany
- (d) Tetanus

Exercise

1. MULTIPLE CHOICE QUESTIONS

1. Which structures are part of the appendicular skeleton?

- (a) Ethmoid bone
- (b) Floating ribs
- (c) Lumbar vertebrae
- (d) Humerus bone

2. The term muscle fibre or myofibre refers to;

- (a) A cellular organelle
- (b) A cell
- (c) A tissue
- (d) An organ

3. Which of these extends the entire length of a muscle fibre?

- (a) Sarcomere
- (b) Myofibril
- (c) Myosin filament
- (d) Actin filament

4. Actin filaments are made of proteins;

- (a) Myosin and troponin
- (b) Actin and troponin
- (c) Actin and myosin
- (d) Actin, tropomyosin and troponin

5. In a muscle, the Z-line are the proteins for the attachment of the ends of;

- (a) Actin filaments
- (b) Myosin filaments
- (c) Both actin and myosin filaments
- (d) Sarcomeres

6. Sarcomere is a part between;

- (a) Two H-lines
- (b) Two A-bands
- (c) Two Z-lines
- (d) Two I-bands

7. Which part of muscle fibre releases calcium ions which trigger contraction?

- (a) Sarcolemma
- (b) Sarcoplasm
- (c) T-tubules
- (d) Sarcoplasmic reticulum

8. Which statement is correct to describe sliding filament model of muscle contraction?

- (a) Myosin filaments pull on the sarcomere so that actin filaments are shortened.
- (b) Myosin filaments pull on actin filaments so that sarcomere is shortened.
- (c) Actin filaments pull on myosin filaments so that sarcomere is shortened.
- (d) Actin filaments pull on sarcomere so that myosin filaments are shortened.

9. When a muscle fibre shortens, which of the following also shortens?

- (a) Actin filament
- (b) Myosin filament
- (c) Sarcomere
- (d) Z-line

10. Which statement correctly describes an event of muscle contraction?

- (a) Myosin heads bind to troponin.
- (b) ATP binds to the actin binding site.
- (c) ATP is used to detach the myosin head from actin.

(d) Tropanin blocks the binding sites.

11. Tendons connect bone and;

- (a) Bone
- (b) Ligaments
- (c) Muscle
- (d) Cartilage

12. What is true about antagonistic pair of muscles?

- (a) It provides a backup if one of the muscles is injured
- (b) One muscle pushes while other pulls
- (c) It allows muscles to produce opposing movements
- (d) It doubles the strength of contraction

2. SHORT QUESTIONS

1. Name three types of cells associated with bone and write their functions.

The three types of bone cells are: osteoblasts, osteocytes, and osteoclasts.

- **Osteoblasts:** Responsible for forming new bone tissue.
- **Osteocytes:** Mature bone cells that maintain bone tissue.
- **Osteoclasts:** Break down bone tissue and help in bone resorption.

2. Name the bones of cranium.

The cranium is made up of eight bones: frontal bone, parietal bones (2), temporal bones (2), occipital bone, sphenoid bone, and ethmoid bone.

3. Enlist the bones in the five groups of vertebrae.

The vertebral column is divided into five groups:

- Cervical vertebrae (7)
- Thoracic vertebrae (12)
- Lumbar vertebrae (5)
- Sacrum (5 fused vertebrae)
- Coccyx (4 fused vertebrae)

4. What bones make the rib cage?

The rib cage is formed by 12 pairs of ribs and the sternum (breastbone), along with the thoracic vertebrae at the back.

5. Name the bones of pectoral girdle and pelvic girdle.

- **Pectoral girdle:** Clavicle (collarbone) and scapula (shoulder blade).
- **Pelvic girdle:** Two hip bones (each made of ilium, ischium, and pubis).

6. Name the bones of forelimbs and hindlimbs.

- **Forelimbs:** Humerus, radius, ulna, carpals, metacarpals, phalanges.
- **Hindlimbs:** Femur, patella, tibia, fibula, tarsals, metatarsals, phalanges.

7. What is fibrous joint? Give examples.

A fibrous joint is a type of immovable joint where bones are joined by fibrous connective tissue.

Examples include the sutures of the skull and the joint between teeth and jaw (gomphosis).

8. Name the steps involved in bone repair.

Bone repair occurs in several steps:

- Formation of a blood clot at the fracture site
- Formation of a soft callus (cartilage)
- Replacement of soft callus with a hard (bony) callus

- Remodelling of bone to restore normal structure and strength

9. What skeletal structures are affected from osteoarthritis?

Osteoarthritis mainly affects the joints, especially the articular cartilage at the ends of bones, along with surrounding ligaments and synovial fluid, leading to joint pain and stiffness.

10. List the major parts of skeletal muscle fibre.

The major parts of a skeletal muscle fibre are:

- Sarcolemma (cell membrane)
- Sarcoplasm (cytoplasm)
- Sarcoplasmic reticulum
- T-tubules
- Myofibrils
- Nuclei (multiple)

11. What do you mean by I-band, A-band and H-zone?

- **I-band:** Light band containing only thin (actin) filaments.
- **A-band:** Dark band containing thick (myosin) filaments along with overlapping actin filaments.
- **H-zone:** Central part of the A-band where only thick filaments are present (no overlap with actin).

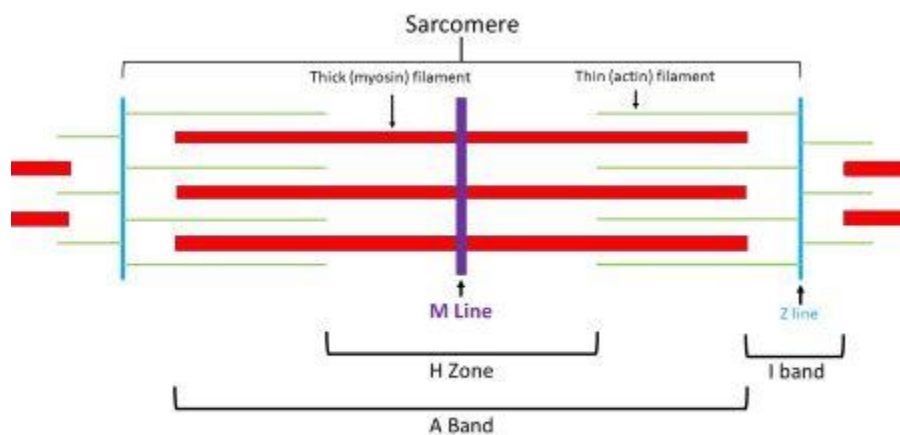
12. Describe the antagonistic arrangement of skeletal muscles.

Antagonistic arrangement means muscles work in pairs to produce opposite movements at a joint. When one muscle contracts, the other relaxes. For example, flexor muscles bend a joint while extensor muscles straighten it. This coordination allows smooth and controlled movement of bones at joints.

13. Ligaments are elastic while tendons are hard. Justify.

Ligaments connect bone to bone and contain more elastic fibres, which provide flexibility and allow movement at joints. Tendons connect muscle to bone and are made of dense collagen fibres, making them strong and less elastic so they can withstand the force of muscle contraction.

14. Draw a diagram of sarcomere and label its parts.



15. Differentiate between the following:

(a) Compact bone vs Spongy bone

- **Compact bone:** Dense, hard, forms outer layer of bones.
- **Spongy bone:** Porous, lighter, found inside bones with trabeculae.

(b) Axial skeleton vs Appendicular skeleton

- **Axial skeleton:** Forms central axis (skull, vertebral column, rib cage).
- **Appendicular skeleton:** Includes limbs and girdles (pectoral and pelvic).

(c) True ribs, false ribs and floating ribs

- **True ribs:** First 7 pairs, directly attached to sternum.
- **False ribs:** Next 3 pairs, indirectly attached to sternum.
- **Floating ribs:** Last 2 pairs, not attached to sternum.

(d) Rheumatoid arthritis vs Osteoarthritis

- **Rheumatoid arthritis:** Autoimmune disease causing inflammation of joints.
- **Osteoarthritis:** Degeneration of cartilage due to wear and tear.

(e) Fibrous joints vs Cartilaginous joints

- **Fibrous joints:** Immovable joints joined by fibrous tissue (e.g., skull sutures).
- **Cartilaginous joints:** Slightly movable joints connected by cartilage (e.g., between vertebrae).

(f) Cartilaginous joint vs Synovial joint

- **Cartilaginous joints:** Limited movement, joined by cartilage.
- **Synovial joints:** Freely movable joints with synovial fluid (e.g., knee, shoulder).

(g) Osteoblasts vs Osteocytes

- **Osteoblasts:** Bone-forming cells.
- **Osteocytes:** Mature bone cells that maintain bone tissue.

(h) Tropomyosin vs Troponin

- **Tropomyosin:** Blocks myosin binding sites on actin in resting muscle.
- **Troponin:** Binds calcium ions and shifts tropomyosin during contraction.

(i) Ligament vs Tendon

- **Ligament:** Connects bone to bone; elastic.
- **Tendon:** Connects muscle to bone; strong and inelastic.

(j) Tetany vs Tetanus

- **Tetany:** Muscle spasms due to low calcium levels (hypocalcaemia).
- **Tetanus:** Bacterial infection caused by *Clostridium tetani* leading to muscle stiffness and spasms; more severe and life-threatening.

3. LONG QUESTIONS

☀ Q1: Explain the structure of bone.

❖ Answer:

Bone is a strong connective tissue that forms the skeletal system and provides support, protection, and movement. The structure of bone is complex and consists of different layers and types of cells.

At the outermost level, a bone is covered by a tough connective tissue called the periosteum, which contains blood vessels and nerves. Inside the periosteum lies the compact bone, which is dense and hard. It is made up of structural units called osteons (Haversian systems). Each osteon consists of concentric rings of calcified matrix called lamellae, arranged around a central Haversian canal. This canal contains blood vessels and nerves that supply nutrients to the bone.

Within the compact bone are small spaces called lacunae, which contain osteocytes (mature bone cells). These osteocytes are connected to each other through tiny channels called canaliculi, allowing the exchange of nutrients and wastes.

Deeper inside the bone lies the spongy (cancellous) bone, which has a porous, lattice-like structure. It contains trabeculae, which are thin bony plates that help reduce the weight of the bone while maintaining strength. The spaces between trabeculae are often filled with bone marrow, which is responsible for producing blood cells.

Bone tissue also contains different types of cells: osteoblasts, which form new bone; osteocytes, which maintain bone tissue; and osteoclasts, which break down bone during growth and repair.

Overall, the combination of compact and spongy bone, along with blood supply and specialized cells, makes bone strong, lightweight, and capable of growth and repair.

☀ Q2: Describe the structure of three types of cartilage.

❖ Answer:

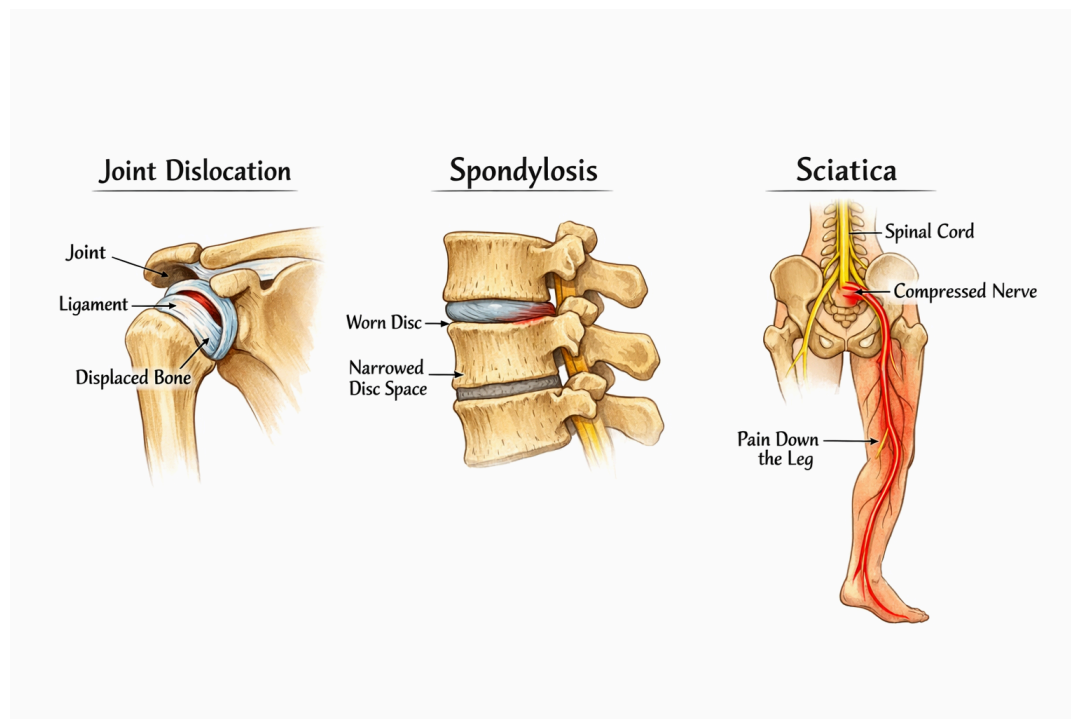
Cartilage is a flexible connective tissue that supports and protects various parts of the body. It consists of cells called chondrocytes embedded in a firm matrix of fibers and ground substance. There are three main types of cartilage: hyaline cartilage, elastic cartilage, and fibrocartilage, each with a distinct structure.

Hyaline cartilage is the most common type. It has a smooth, glass-like appearance due to a homogeneous matrix containing fine collagen fibers. The chondrocytes are located in small spaces called lacunae and are often found in groups. This type of cartilage is found at the ends of long bones, in the nose, trachea, and at the costal cartilages of ribs. Its matrix is firm but somewhat flexible.

Elastic cartilage contains a dense network of elastic fibers in its matrix, in addition to chondrocytes in lacunae. These elastic fibers give it greater flexibility and resilience, allowing it to return to its original shape after bending. It is found in structures such as the external ear (pinna) and the epiglottis.

Fibrocartilage is the strongest type of cartilage. Its matrix contains thick bundles of collagen fibers arranged in a dense pattern, with chondrocytes present in lacunae between these fibers. It has very little ground substance compared to the other types. Fibrocartilage provides high tensile strength and resistance to pressure and is found in intervertebral discs, the pubic symphysis, and knee joint menisci.

☀ Q3: Write the cause and symptoms of joint dislocation, spondylosis, and sciatica.



❖ **Answer:**

(a) Joint Dislocation

Cause:

Joint dislocation occurs when a bone is forced out of its normal position in a joint due to sudden impact, fall, accident, or excessive force during movement or sports injuries. It may also occur due to weak ligaments.

Symptoms:

- Severe pain in the affected joint
- Swelling and inflammation
- Deformity or abnormal position of the joint
- Difficulty or inability to move the joint
- Loss of function in the affected area

(b) Spondylosis

Cause:

Spondylosis is caused by age-related degeneration of the vertebrae and intervertebral discs. It may also result from wear and tear, poor posture, long-term stress on the spine, or lack of physical activity.

Symptoms:

- Neck or back pain
- Stiffness in the spine
- Reduced flexibility and movement
- Numbness or tingling in limbs (in severe cases due to nerve compression)
- Weakness in muscles

(c) Sciatica

Cause:

Sciatica is caused by compression or irritation of the sciatic nerve, often due to a herniated disc, spinal stenosis, injury, or bone spurs pressing on the nerve.

Symptoms:

- Sharp pain radiating from the lower back to the leg
- Pain in the buttock and down one side of the leg
- Tingling or numbness in the leg or foot
- Muscle weakness in the affected leg
- Difficulty in standing, walking, or sitting for long periods

☀ **Q4: Describe the types of arthritis, with their causes, symptoms and treatments.**

❖ **Answer:**

Arthritis is a group of disorders that involve inflammation of joints, leading to pain, stiffness, and reduced movement. The two most common types are osteoarthritis and rheumatoid arthritis.

(a) Osteoarthritis

Cause:

Osteoarthritis is mainly caused by wear and tear of joint cartilage due to aging, repeated use of joints, obesity, joint injury, or excessive mechanical stress over time. The cartilage that cushions the ends of bones gradually deteriorates.

Symptoms:

- Joint pain, especially during movement
- Stiffness after rest or inactivity
- Swelling in joints
- Reduced flexibility and range of motion
- Grating sensation during movement

Treatment:

- Pain-relieving medications (analgesics, anti-inflammatory drugs)
- Physiotherapy and regular mild exercise
- Weight control to reduce joint stress
- In severe cases, joint replacement surgery

(b) Rheumatoid Arthritis

Cause:

Rheumatoid arthritis is an autoimmune disease in which the immune system mistakenly attacks the lining of joints (synovial membrane), causing chronic inflammation. Genetic and environmental factors may contribute to its development.

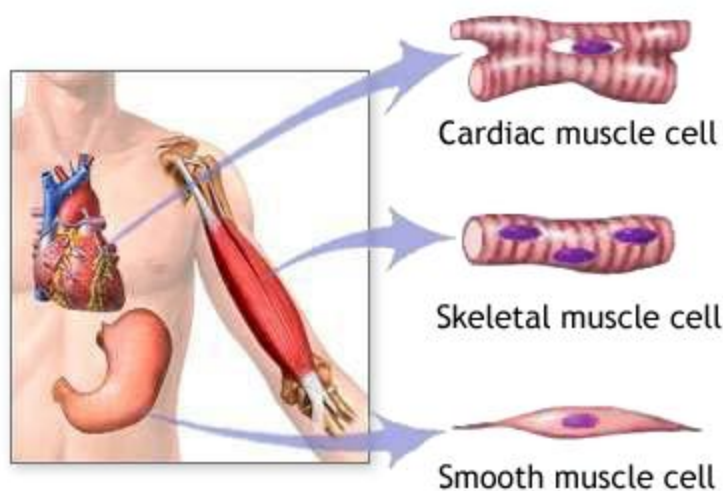
Symptoms:

- Pain and swelling in joints
- Morning stiffness lasting for a long time
- Redness and warmth around joints
- Symmetrical joint involvement (affects both sides of the body)
- Fatigue and general weakness

Treatment:

- Anti-inflammatory drugs and immunosuppressive medications
- Disease-modifying antirheumatic drugs (DMARDs)
- Physiotherapy and controlled exercise
- Rest during flare-ups
- In advanced cases, surgery may be required

☀ Q5: Describe the three types of muscles.



Answer: There are three types of muscles in the human body: skeletal muscles, smooth muscles, and cardiac muscles. They differ in structure, location, and function.

(a) Skeletal Muscles

Skeletal muscles are attached to bones and are responsible for voluntary movements of the body such as movement of limbs, face, and trunk. These muscles are made of long, cylindrical fibres that are striated (striped) and contain multiple nuclei. Their contraction is under conscious control, so they are also called voluntary muscles. They are connected to bones by tendons.

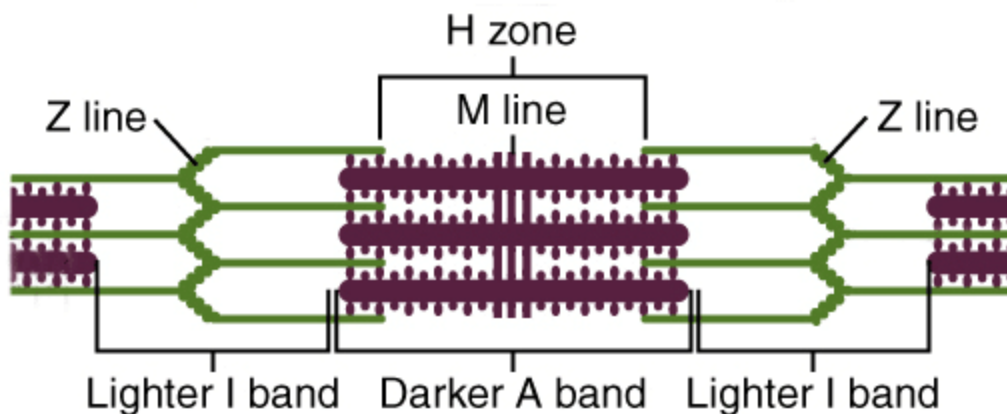
(b) Smooth Muscles

Smooth muscles are found in the walls of internal organs such as the stomach, intestines, blood vessels, and urinary bladder. The muscle fibres are spindle-shaped, have a single nucleus, and lack striations. Their actions are not under conscious control, so they are called involuntary muscles. They control slow and automatic movements like digestion and blood flow.

(c) Cardiac Muscles

Cardiac muscles are found only in the heart. Their fibres are striated, branched, and usually contain a single nucleus. These muscles work continuously and rhythmically without fatigue. They are involuntary and are responsible for pumping blood throughout the body.

☀ Q6. Explain the ultrastructure of skeletal muscle.



❖ Answer:

The ultrastructure of skeletal muscle refers to the fine internal structure of a muscle fibre (cell) as seen under a microscope. A skeletal muscle fibre is a long, cylindrical, multinucleated cell surrounded by a plasma membrane called the sarcolemma.

Inside the sarcolemma is the cytoplasm called sarcoplasm, which contains sarcoplasmic reticulum (SR) and many elongated thread-like structures called myofibrils. The sarcolemma also forms inward extensions called T-tubules, which help in conducting impulses deep into the muscle fibre.

Each muscle fiber contains numerous myofibrils, and each myofibril is made up of repeating units called sarcomeres, which are the functional units of contraction. Sarcomeres are arranged end to end along the myofibril and are responsible for the striated appearance of skeletal muscle.

Within a sarcomere, there are two types of protein filaments: thin filaments (actin) and thick filaments (myosin). The arrangement of these filaments forms distinct bands:

- **A-band:** Dark region containing thick filaments and overlapping thin filaments
- **I-band:** Light region containing only thin filaments
- **H-zone:** Central part of A-band with only thick filaments
- **Z-line:** Boundary of a sarcomere where actin filaments are anchored
- **M-line:** Center of the sarcomere stabilizing thick filaments

The sarcoplasmic reticulum stores calcium ions, which are released during muscle contraction. The interaction between actin and myosin filaments, along with calcium ions, enables contraction through the sliding filament mechanism.

☀ **Q7: Write a detailed note on the sliding filament model of muscle contraction.**

❖ **Answer:**

The sliding filament model explains how muscles contract at the molecular level. According to this model, muscle contraction occurs when thin (actin) filaments slide over thick (myosin) filaments, increasing the overlap between them and shortening the sarcomere. This process takes place in several steps.

In a relaxed muscle, the sarcomeres are at their normal length. The binding sites on actin filaments are covered by the protein tropomyosin, which prevents myosin heads from attaching. Another protein, troponin, is attached to tropomyosin. Myosin heads are energized because ATP has been hydrolysed into ADP and Pi, but they remain unbound.

When a nerve impulse reaches the muscle fibre, it travels along the sarcolemma and through the T-tubules to the sarcoplasmic reticulum (SR). The SR releases calcium ions (Ca^{2+}) into the sarcoplasm. These calcium ions bind to troponin, causing a shift in tropomyosin and exposing the binding sites on actin filaments.

Once the binding sites are exposed, the myosin heads attach to actin, forming cross-bridges. The myosin heads then release ADP and Pi and undergo a conformational change known as the power stroke. During the power stroke, myosin heads bend and pull the actin filaments toward the center of the sarcomere. This results in shortening of the sarcomere, bringing Z-lines closer together. The H-zone and I-band decrease in size, while the A-band remains unchanged.

After the power stroke, a new ATP molecule binds to the myosin head, causing it to detach from actin. The ATP is then hydrolysed into ADP and Pi, re-energizing the myosin head so it can attach again to a new binding site on actin. This cycle repeats many times, producing continuous contraction.

When the nerve impulse stops, calcium ions are pumped back into the sarcoplasmic reticulum. Tropomyosin again covers the binding sites on actin, and the muscle relaxes.

This model explains how repeated cycles of cross-bridge formation and detachment lead to muscle contraction. In the absence of ATP, myosin heads cannot detach from actin, which causes rigor mortis, a condition where muscles remain stiff after death.

☀ **8. Explain the action of antagonistic muscles in the movement of knee joint.**

❖ **Answer:**

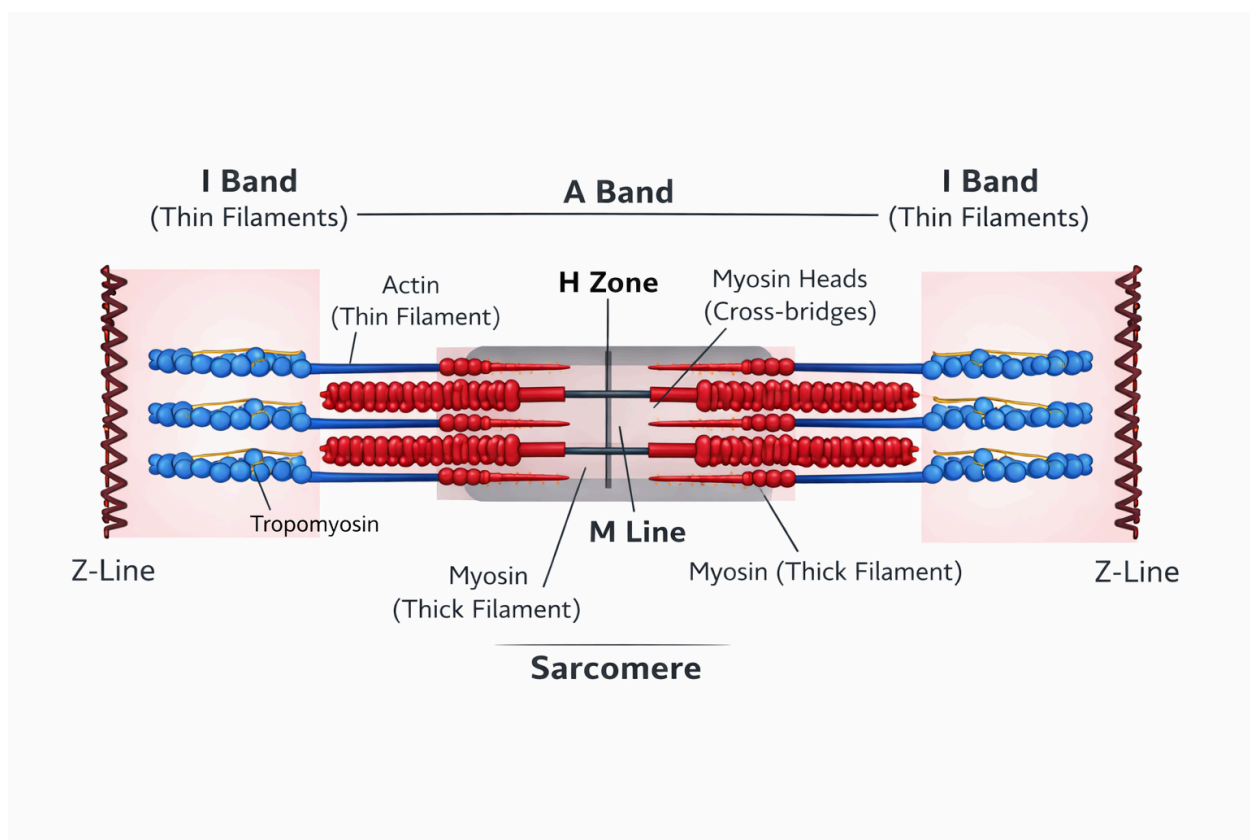
Antagonistic muscles are pairs of muscles that work opposite to each other to produce movement at a joint. In the movement of the knee joint, the main antagonistic muscle pair is the quadriceps (front of thigh) and the hamstrings (back of thigh).

When the knee is extended (straightened), the quadriceps contract while the hamstrings relax. The quadriceps pull on the patella and through the patellar tendon, they extend the lower leg at the knee joint. This movement straightens the leg.

When the knee is flexed (bent), the hamstrings contract while the quadriceps relax. The hamstrings pull the lower leg backward, causing flexion at the knee joint.

Thus, these two muscle groups act in opposition. One muscle contracts while the other relaxes, allowing smooth and controlled movement of the knee joint. This coordination prevents injury and ensures proper locomotion.

☀ **Q9. Draw a diagram of sarcomere and label its parts.**



Explanation of Sarcomere

A sarcomere is the functional unit of a muscle fibre responsible for muscle contraction. It is the segment between two Z-lines (Z-discs).

Inside the sarcomere, two types of protein filaments are present:

1. Thin filaments (Actin)
2. Thick filaments (Myosin)

These filaments are arranged in a specific pattern to produce striations.

Main Parts of Sarcomere

Z-line (Z-disc):

- Boundary of a sarcomere where actin filaments are anchored.

I-band:

- Light region containing only thin (actin) filaments.

A-band:

- Dark region containing thick (myosin) filaments along with overlapping actin filaments.

H-zone:

- Central part of the A-band where only myosin filaments are present (no actin overlap).

M-line:

- Middle line of the sarcomere that holds the myosin filaments together.

Key Points

- During contraction, actin filaments slide over myosin filaments.

-
- The Z-lines move closer, causing the sarcomere to shorten.
 - The I-band and H-zone decrease, while the A-band remains constant.

☀️ **Q10: Describe causes and symptoms of muscle fatigue, cramps and tetany.**

(a) Muscle Fatigue

Causes:

Muscle fatigue occurs when muscles are used continuously without adequate rest. It is mainly caused by the accumulation of lactic acid due to anaerobic respiration, depletion of energy (ATP), and reduced oxygen supply to muscle tissues.

Symptoms:

- Weakness in muscles
- Reduced ability to contract
- Pain or discomfort in muscles
- Feeling of tiredness and heaviness in the affected muscles
- Decreased performance of muscle activity

(b) Muscle Cramps

Causes:

Muscle cramps are sudden, involuntary contractions of muscles. They may be caused by electrolyte imbalance (low calcium, potassium, or magnesium), dehydration, overuse of muscles, poor blood circulation, or nerve irritation.

Symptoms:

- Sudden sharp pain in the muscle
- Hardening or tightening of the muscle
- Temporary inability to relax the muscle
- Visible muscle spasm
- Difficulty in movement of the affected part

(c) Tetany

Causes:

Tetany is caused by low calcium levels (hypocalcemia) in the blood. Calcium is essential for normal muscle contraction, and its deficiency increases nerve excitability, leading to uncontrolled muscle contractions.

Symptoms:

- Continuous and involuntary muscle contractions
- Muscle spasms or twitching
- Tingling sensation in hands, feet, and around the mouth
- Severe cases may cause convulsions
- Muscle stiffness and cramps in multiple areas

☀ **Q11: Justify how the main functions of the skeleton are to act as a system of rods and levers.**

❖ Answer:

The skeleton functions as a system of rods and levers because bones, joints, and muscles work together to produce movement. In this system:

- Bones act as rods (rigid structures) that provide support and act as levers.
- Joints act as fulcrums (pivot points) around which movement occurs.
- Muscles provide the force required to move the bones by pulling on them through tendons.

When a muscle contracts, it pulls on a bone, causing it to move around a joint. This movement is similar to a lever system in physics, where a force applied at one point produces movement at another point.

For example, in the movement of the forearm at the elbow joint:

- The elbow joint acts as a fulcrum
- The biceps muscle contracts to lift the forearm
- The forearm bone (radius/ulna) acts as a lever

Since muscles can only contract (pull) and not push, they work in pairs (antagonistic muscles) to produce opposite movements, further supporting the lever mechanism.

Thus, the skeleton, along with muscles and joints, forms a mechanical system that enables efficient movement of the body by acting as rods and levers.

☀ **Q12: Justify why do the muscles pull but do not push.**

❖ **Answer:**

Muscles can only pull and not push because of their structural and functional properties. Muscle fibres are attached to bones through tendons. When a muscle contracts, the fibres shorten and generate a pulling force on the attached bone.

Muscles work by the sliding filament mechanism, where actin and myosin filaments slide over each other to shorten the muscle. This shortening creates tension that can only be transmitted in one direction—pulling the bone toward the muscle.

Another important reason is that muscles are arranged in antagonistic pairs. One muscle contracts (pulls) while the opposing muscle relaxes, allowing movement in the opposite direction. Since a muscle can actively contract but cannot actively lengthen to push, movement in the opposite direction is achieved by the opposing muscle contracting.

Therefore, due to their contraction-based mechanism and attachment via tendons, muscles are capable of producing pulling forces only, not pushing forces.

INQUISITIVE QUESTIONS

Q1: Why is calcium essential for both the structural integrity of bones and the process of muscle contraction?

❖ **Answer:**

Calcium is essential for bones because it provides strength and hardness. Bones are made of a matrix that contains collagen fibers and mineral salts, mainly calcium phosphate. These calcium salts make bones rigid and resistant to pressure. Without sufficient calcium, bones become weak, soft, and prone to fractures.

Calcium is also crucial for muscle contraction. When a nerve impulse reaches a muscle fibre, calcium ions (Ca^{2+}) are released from the sarcoplasmic reticulum into the sarcoplasm. These calcium ions bind to troponin, causing a shift in tropomyosin and exposing binding sites on actin filaments. This allows myosin heads to form cross-bridges with actin, leading to contraction through the sliding filament mechanism.

Thus, calcium plays a dual role: it ensures the structural strength of bones and enables the biochemical process of muscle contraction. Without calcium, both bone stability and muscle function would be impaired.

☀ **Q2: Why is the human skeleton designed with both rigid bones and flexible joints instead of being made of a single solid structure?**

❖ **Answer:**

The human skeleton is designed with rigid bones and flexible joints to allow both support and movement. If the skeleton were a single solid structure, the body would be very strong but completely immobile.

Rigid bones provide shape, support, and protection to vital organs such as the brain, heart, and lungs. They also act as levers for muscles to produce movement.

Flexible joints connect bones and allow them to move relative to each other. Different types of joints permit different ranges of motion, such as bending, rotating, and gliding. **For example**, the knee joint allows flexion and extension, while the shoulder joint allows a wide range of movements.

Muscles pull on bones across joints to produce movement. Without joints, muscles would not be able to create motion effectively.

Therefore, the combination of rigid bones for strength and flexible joints for mobility enables the human body to maintain structure while still allowing a wide range of controlled movements.

☀ **Q3: Why do muscles always work in pairs (antagonistic muscles) rather than alone?**

❖ **Answer:**

Muscles always work in pairs, called antagonistic muscles, because a muscle can only contract (pull) and cannot actively push or lengthen. To produce movement in opposite directions, two muscles with opposite actions are required.

When one muscle contracts, the other muscle in the pair relaxes. For example, in the movement of the arm:

- The biceps contracts to bend (flex) the arm
- The triceps relaxes
- To straighten (extend) the arm, the triceps contracts and the biceps relaxes

This coordinated action allows smooth and controlled movement at joints. If muscles worked alone, movement would only occur in one direction and returning to the original position would not be possible.

Therefore, antagonistic muscle pairs are essential because they provide opposite actions, balance, precision, and control of movement in the body.

☀ **Q4: Why does prolonged inactivity or space travel lead to muscle atrophy and bone weakening?**

❖ **Answer:**

Prolonged inactivity (bed rest, lack of exercise) and space travel (microgravity) reduce the normal mechanical stress on muscles and bones. Under normal conditions, regular movement and weight-bearing activities stimulate muscles and bones to remain strong.

When muscles are not used for a long time, they receive fewer signals for contraction. As a result, muscle protein synthesis decreases while protein breakdown increases, leading to muscle atrophy (loss of muscle mass and strength).

Similarly, bones require regular stress to maintain their density. In the absence of gravitational force or physical activity, bone cells (especially osteoblasts) become less active, while bone resorption by osteoclasts may increase. This leads to a decrease in bone mineral density, causing bone weakening and a higher risk of fractures.

In space, the lack of gravity means bones and muscles are not bearing weight, which accelerates both muscle atrophy and bone loss. This is why astronauts follow strict exercise routines to minimize these effects.

Thus, prolonged inactivity or microgravity leads to reduced stimulation of muscles and bones, resulting in muscle wasting and decreased bone strength.

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