

Unit 12: Human Skeletal and Muscular Systems

Short Questions

SHORT ANSWER QUESTIONS EXERCISE

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

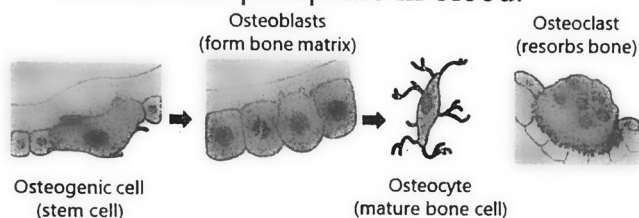
Ans. Types of Bone Cells

There are three types of cells i.e., osteoblasts, osteocytes, and osteoclasts involved in the development, growth and remodelling of bones.

- 1. Osteoblasts** are bone forming cells that synthesize and secrete unmineralized ground substance. Once the osteoblasts are surrounded by matrix, they become the osteocytes.
- 2. Osteocytes** are mature bone cells which maintain healthy bone tissue by secreting enzymes and bone mineral

content. They also regulate the calcium release from bone tissue to blood.

3. **Osteoclasts** develop from macrophages and are involved in bone resorption, i.e., they break down bone and release calcium and phosphate in blood.



Q.2 Name the bones of cranium.

Ans. Eight cranial bones form cranium also called brain box.

- Paired bones:** Two paired bones, parietal and temporal.
- Unpaired bones:** Four unpaired bones, Frontal, occipital, ethmoid and sphenoid.

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

Ans. Vertebral column: It consists of 33 vertebrae. The vertebrae make five groups:

- Seven cervical vertebrae:** These are the vertebrae of the neck. The first one is called **atlas** and the second one is called **axis**.
- Twelve thoracic vertebrae:** These are rib-carrying vertebrae and are found in chest region.
- Five lumbar vertebrae:** These are present in abdominal region.
- Five sacral vertebrae:** These are five fused vertebrae forming the sacrum. The sacrum articulates with the iliac bones of the hip to form the back of the pelvis.
- Four coccygeal vertebrae or coccyx:**

Q.6 Name the bones of forelimbs and hindlimbs.

Ans.

Fore Limb	Hindlimb
• One humerus	• One femur
• One ulna and one radius	• One tibia and one fibula, one patella
• Eight carpels	• Seven tarsals
• Five meta carpels	• Five metatarsals
• Fourteen phalanges	• Fourteen phalanges

These vertebrae are fused in the adults. Sacral and coccygeal vertebrae are together called pelvic vertebrae.

Q.4 What bones make the rib cage?

Ans. The rib cage consists of 24 bones (12 pairs) called **ribs** and a **sternum**. The sternum (chest bone) is a long flat bone located in the central part of the chest. The ribs articulate posteriorly with the thoracic vertebrae.

True ribs: On anterior side, first 7 pairs of ribs attach directly with the sternum by means of separate costal cartilages. These are called **true ribs**.

False ribs: The 8th, 9th and 10th pairs attach to the sternum by means of a common costal cartilage and are called **false ribs**.

Floating ribs: The last 2 pairs of ribs (11th and 12th) are known as floating ribs, because they do not attach to the sternum.

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

Ans. Pectoral girdle: It consists of 2 pairs i.e., a pair of clavicles (collar bones) and a pair of scapulae (shoulder bones). One end of each clavicle articulates with the sternum. The other end articulates with the scapula.

Pelvic girdle: It is made up of two hip bones. Each hip bone contains 3 fused bones i.e., ilium, ischium and pubis. In each hip bone, there is a bony socket, called **acetabulum** that is formed by the fusion of three bones. The two hip bones are joined at the front by the pubic symphysis (a cartilaginous joint that connects the pubic bones at the midline of the body).

Q.7 What is fibrous joint? Give examples.

Ans. Fibrous Joints: In fibrous joints, the bones are directly connected to each other by fibrous connective tissue consisting mainly of collagen. These joints permit no movement of bones. Examples of fibrous joints include:

- **Sutures** that occur only between the immovable bones of the skull.
- Joints between the tibia and fibula bones in the lower leg.
- Joints between **teeth and their sockets** in the jawbone (mandible).

Q.8 Name the steps involved in bone repair.

Ans.

- Hematoma formation
- Soft callus formation
- Bony callus formation
- Remodelling

Q.9 Which skeletal structures are affected from the osteoarthritis?

Ans. Osteoarthritis is the most common chronic arthritic. It occurs when the articular cartilage at the ends of bones in joints gradually softens and disintegrates. It affects **knee, hip and intervertebral joints**.

Q.10 List the major parts of skeletal muscle fibre.

Ans. Each skeletal muscle cell i.e., muscle fibre is a cylindrical **multinucleated cell**, enclosed by a plasma membrane called **sarcolemma**. Its cytoplasm is called sarcoplasm and it contains **sarcoplasmic reticulum (SR)**. The sarcolemma penetrates deep into the cell to form hollow elongated tubes, the **transverse tubules (T-tubules)**. The T-tubules reach the ends of SR.

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

Ans.

I-Band: The thin filaments of myofibril in a muscle cell create light bands called I-band (isotropic: they can't polarize light). These thin filaments are attached to protein discs

called **Z-lines** (Zwischen: in between). They are composed of **actin**.

A-band: The thick filaments of myofibril in muscle fibre create dark bands called **A-Band** (Anisotropic: they can polarize light). They are composed of myosin.

H-zone: The region in A-Band which appears lighter (where no overlap between thick and thin filaments occur) is called **H-zone** (hele = bright).

Q.12 Describe the antagonistic arrangement of skeletal muscles.

Ans. For the movement of bones at a joint in two directions muscles work in pairs. They produce opposing actions when they contract. Such arrangement of muscles is called antagonistic arrangement. In such arrangement, when one muscle, called **flexor**, contracts it bends the bone at joint. When the opposing muscle, called **extensor**, contracts it straightens the bone at joints.

- During antagonistic action, when a muscle e.g., flexors contracts, the other muscle i.e., extensor is relaxed and vice versa.

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

Ans.

- **Ligaments** can stretch slightly under stress and retain to their original shape due to higher amount of elastin.
- **Tendons** are stiffer and resist stretching to efficiently transfer muscle forces due to higher collagen and relatively low elastin.

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

Ans.

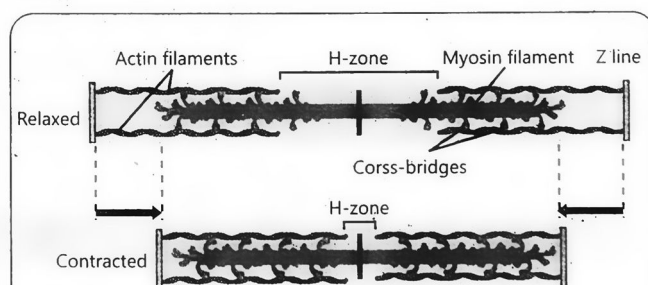


Figure: Sliding filament model of muscle contraction

Q.15 Differentiate between:

- Compact and spongy bone
- Axial skeleton and appendicular skeleton
- True ribs, false ribs and floating ribs
- Rheumatoid arthritis and osteoarthritis
- Fibrous and cartilaginous joints
- Cartilaginous and synovial joint
- Osteoblasts and osteocytes
- Tropomyosin and troponin
- Ligament and tendon
- Tetany and tetanus

Ans. Compact and spongy bone

Compact bone	Spongy bone
• The outer thick layer of bone under the periosteum is called compact bone. • It is made of hard material. • It provides attachment and surface for muscles.	• The inner thin layer of bone under compact bone is called spongy bone. • It is made up of latticework structure, consisting of bony spikes making it light and strong, • It contains bone marrow so acts as a site for blood cells production.

Axial skeleton and appendicular skeleton

Axial skeleton	Appendicular skeleton
• The axial skeleton forms the axis of the body. Its bones support and protect the organs of the head, neck, and chest. • It consists of skull, ribs, spine, and sternum.	• Appendicular skeleton includes the bones present in appendages (arms and legs). • These are pectoral girdle, pelvic girdle, forelimbs and hind limbs.

True ribs, false ribs and floating ribs

True ribs	False ribs	Floating ribs
• The first seven pairs of ribs articulate directly with sternum by means of separate costal cartilages, these are called true ribs.	• The 8th, 9th and 10th pairs of ribs are attached to sternum by means of common costal cartilage, are called false ribs.	• The last 2 pairs of ribs 11th, 12th do not attach to the sternum, that's why they are called floating ribs.

Rheumatoid arthritis and osteoarthritis

Rheumatoid Arthritis	Osteoarthritis
• It is result of an autoimmune disorder in which synovial membrane becomes inflamed.	• The type of arthritis in which articular cartilage at ends of bones in joints gradually softens and disintegrates.

- | | |
|---|---|
| <ul style="list-style-type: none"> Most commonly, the wrist and hands are involved. | <ul style="list-style-type: none"> It affects knee, hip and intervertebral joints. |
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Fibrous and cartilaginous joints

Fibrous joints	Cartilaginous joints
- In fibrous joints, the bones are directly connected to each other by fibrous connective tissue consisting mainly of collagen. - These joints permit no movement of bones. Examples of fibrous joints include: Sutures that occur only between the immovable bones of the skull.	- In these joints, the bones are connected by a layer of cartilage. - Cartilaginous joints allow little movement of the bones. - There are two main types of cartilaginous joints: Primary cartilaginous joints (synchondrosis) Secondary cartilaginous joints (symphysis)

Cartilaginous and synovial joint

Cartilaginous joint	Synovial joint
- The type of joints in which, the bones are connected by a layer of cartilage. Cartilaginous joints allow little movement of the bones. - There are two main types of cartilaginous joints: Primary cartilaginous joints (synchondrosis): In some cartilaginous joints, the bones are connected by hyaline cartilage e.g., the joint between the first rib and sternum Secondary cartilaginous joints (symphysis): In some cartilaginous joints, the bones are connected by fibrocartilage e.g., pubic symphysis in the pelvic girdle and intervertebral discs.	- Synovial joints are the most common type of joint in the human body, and they allow a wide range of movement. - A smooth, tough, and elastic hyaline cartilage, called articular cartilage, covers the ends of the bones in the joint. - It provides a smooth and frictionless surface for movement. - A fibrous capsule surrounds the synovial joint. - The fibrous capsule is composed of an outer layer of ligaments and an inner lining of synovial membrane, which secretes synovial fluid, that lubricates the joint.

Osteoblasts and osteocytes

Osteoblasts	Osteocytes
Osteoblasts are bone forming cells that synthesize and secrete unmineralized ground substance. - Once the osteoblasts are surrounded by matrix, they become the osteocytes.	Osteocytes are mature bone cells which maintain healthy bone tissue by secreting enzymes and bone mineral content. - They also regulate the calcium release from bone tissue to blood.

Tropomyosin and troponin

Tropomyosin	Troponin
The thin myofilaments have two strands of polypeptides which wrap actin core and stiffen it. In a relaxed muscle fibre, they block myosin binding sites on actin.	Troponin is a component of thin myofilaments present at regular intervals. It is made up of three polypeptides. TnI = inhibitory polypeptide TnT = binds to tropomyosin TnC = binds calcium ions.

Ligament and tendon

Ligaments	Tendons
• They are connective tissues which attach bone to bone. • They are slightly elastic. • Example: Lateral and medial ligaments of foot.	• They are connective tissues which attach muscles to bones. • They are non-elastic/inelastic. • Example: Biceps tendon.

Tetany and tetanus

Tetany	Tetanus
• Tetany is a condition characterized by involuntary muscle contractions or spasms due to increased muscle tone and hyperexcitability of the nerves. • The most common cause of tetany is hypocalcaemia (low level of calcium in blood) which may be due to vitamin D deficiency. • Tetany can affect various body parts like the hands, feet, face or larynx. • Tetany is less serious and potentially not life-threatening compared to tetanus.	• Tetanus is a severe bacterial infection caused by <i>Clostridium tetani</i>, which produces a toxin affecting the nervous system, leading to muscle stiffness and spasms. • Tetanus mainly affects the jaw and neck muscles. • Tetanus is more serious and potentially life-threatening compared to tetany.

SLO BASED SHORT QUESTION ANSWERS

Bone and Cartilage

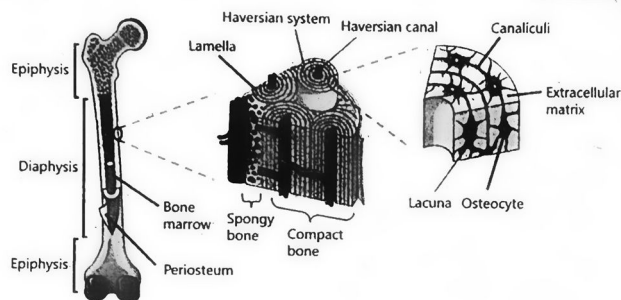
Q.16 What are Haversian canals? Describe their components.

Ans.

Haversian canal: the concentric layers of lamellae surround a central canal called the Haversian canal.

Components: It contains blood vessels, nerves and lymphatic vessels.

In addition to these structures, there are small channels that run perpendicular to the Haversian canals and connect them with each other and with the periosteum. Collagen fibres anchor the periosteum to the underlying bone tissue, providing additional strength and stability to the bone.

Q.17 Sketch a bone and label its parts.**Ans.****Figure: Structure of bone****Q.18 What is bone marrow? Differentiate between red and yellow marrow.**

Ans. Many bones contain a soft tissue called **bone marrow**, which can be either red or yellow.

- **Red bone marrow** is found in **spongy bone**, the **ends of long bones**, **ribs**, **vertebrae**, the **sternum**, and the **pelvis**. It produces red blood cells, platelets, and white blood cells.
- **Yellow bone marrow** fills the **shafts of long bones**. It consists of **fat cells** and serves as an energy reserve. It can also be converted to red bone marrow and produce blood cells when severe blood loss occurs.

Q.19 Define osteogenesis. Describe the formation of long bones.**Ans. Definition**

- The process of bone formation is also called **osteogenesis**.

Formation

- It begins during embryonic development and continues throughout life, playing a vital role in growth, maintenance, and repair of bones.
- There are two primary pathways of osteogenesis.
- The formation of long bones e.g., femur and humerus, involves the transition of cartilage into bone. In this process, the center of cartilage begins to harden (calcify), and the chondrocytes (cartilage cells) in this area die, leaving behind cavities. Blood vessels penetrate these

cavities and introduce osteoblasts and osteoclasts.

Q.20 Describe the formation of short bone.**Ans.**

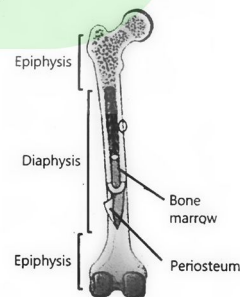
- A few bones, e.g., some bones of the skull, develop directly into hard bone without forming cartilage first.
- In these cases, the osteocytes are initially scattered randomly throughout the embryonic connective tissue but soon fuse into layers and become flat plates of bones.

Q.21 Define Ossification.

Ans. The step in the formation of bone by which cartilage is replaced by bone by the deposition of minerals is called **ossification**.

★Q22. Define periosteum, also describe the parts of bone.**Ans.**

- **Periosteum:** The bone's surface is covered by a tough layer of connective tissue called periosteum.
- **Parts of bone:** The broad ends of a bone are called **epiphysis** while the middle part along the length of bone is called **diaphysis** or shaft.

**Figure: Structure of bone****Q.23 Describe the composition of perichondrium and cartilage matrix.****Ans.**

- A layer of connective tissue called **perichondrium** surrounds the cartilage.
- It contains blood vessels, lymphatic vessels, and nerves that supply the cartilage tissue.
- Inside perichondrium is the **cartilage matrix** which is composed of collagen, elastin, proteoglycans, and other fibres. It

gives the tissue its strength, flexibility, and resistance to compression.

- Unlike other connective tissues, there are no blood vessels inside cartilage matrix. The cells of cartilage are supplied by diffusion. Because of this, it heals very slowly

Q.24 Which cells are present in cartilages how they are related to lacunae?

Ans.

- The cartilage cells, called **chondrocytes**, are present within small spaces called **lacunae**, which are embedded in cartilage matrix. Chondrocytes are responsible for synthesizing and maintaining the matrix of cartilage.

Q.25 Describe the comparison between bone and cartilage.

Ans.

Comparison between Bone and Cartilage		
Feature	Bone	Cartilage
External covering	Periosteum	Perichondrium
Cell types	Osteoblast, osteocytes and osteoclasts	Chondrocytes
Extracellular matrix	Contains calcium crystals and collagen fibres	Contains collagen and other fibres
Blood vessels	Present	Absent
Growth & repair	Have the ability to grow and repair themselves throughout life	Has limited ability to repair itself, as it has no direct blood supply

Q.26 Name the facial bones.

Ans.

- Fourteen **facial bones** are attached to the cranium.
- The **6 paired bones** are lacrimal, zygomatic, nasal bones, inferior nasal concha, maxilla and palatine.
- The **2 unpaired bones** are mandible (lower jaw bone) and vomer.

Q.27 Name the bones of middle ear and neck.

Ans.

- **Middle ear:** There are 6 bones (3 pairs) in middle ears. These are called ossicles and include malleus, incus and stapes.
- **Neck bone:** Hyoid bone is a small single bone which lies at the base of skull below the tongue. It does not articulate with any other bone of head.

Q.28 What is fibrous capsule or joint capsule? Give its composition.

Ans. A **fibrous capsule** surrounds the synovial joint and helps to hold the bones together. The fibrous capsule is composed of an outer layer of ligaments and an inner lining of synovial membrane, which secretes **synovial fluid**, which lubricates the joint.

Q.29 Name the types of synovial joints base on range of motion with one example each.

Ans. There are **six main types** of synovial joints based on the range of motion.

- **Ball-and-socket joints** allow movement in all directions e.g., shoulder and hip joints.
- **Hinge joints** allow movement in only one plane, like a door hinge e.g., elbow and knee joints.

- **Pivot joints** allow rotational movement around a single axis e.g., joint between the first and second vertebrae of the neck.
- **Ellipsoidal joints** allow movement in two planes, but not rotation e.g., joint of wrist with radius.
- **Saddle joints** allow movement in two planes because one bone has a concave surface and the other has a convex surface e.g., thumb joint.
- **Gliding joints** allow gliding movements between bones e.g., joints between the vertebrae and the joints between the bones in wrist and ankle.

Q.30 What is joint transplant? Describe total and partial joint replacement.

Ans. Joint Transplantation

It is a surgical procedure in which a damaged joint is replaced with a healthy natural joint (from donor) or an artificial joint. The most common types of joint transplantation are:

Total joint replacement: In this procedure, the entire damaged joint is replaced with an artificial joint made of metal, plastic, or ceramic.

Partial joint replacement: In this procedure, only the damaged part of the joint is replaced with an artificial component. This is often used in the knee joint.

Q.31 Differentiate between allograft transplantation and chondrocyte implantation.

Ans.

Allograft	Chondrocyte Implantation
• It is a type of joint transplantation in which a healthy joint from a donor is transplanted to replace the damaged joint. • This technique is often used in the ankle and knee joints.	• It is a surgical procedure, in which chondrocytes from patient's own joint are implanted into the damaged joint. • This technique is often used in the knee joint.

Disorders of Skeletal System

Q.32 What problems can arise due to improper posture?

Ans. Problems due to Improper Posture: Improper posture can negatively affect bones and joints, causing:

Vertebral misalignment: This can lead to back and neck pain, and herniated discs by putting pressure on vertebrae and nerves.

Joint strain: Poor posture can strain neck, shoulders, hips, and knees, leading to pain, inflammation, and potentially arthritis.

Muscle imbalances: Overused and underused muscles from poor posture can pull bones and joints out of alignment

Q.33 How an intervertebral disc gets herniated? Describe its causes and symptoms.

Ans. The intervertebral discs between vertebrae act as shock absorbers and help in movement.

Causes

- A herniated or slipped disc occurs when the **outer layer** of the intervertebral disc **tears or ruptures**, causing the inner gel-like substance to leak out and press against nearby nerves or spinal cord. It may be due to a trauma, degenerative changes due to aging, or repetitive strain on vertebral column.

Symptoms: Symptoms of slipped disc include pain, numbness, and tingling in the affected area, weakness or loss of muscle function, and in severe cases, bowel or bladder dysfunction.

Q.34 Define spondylosis describe its causes and symptoms.

Ans.

- Spondylosis means degeneration of vertebrae, intervertebral discs, ligaments or cartilage of vertebral column.

Causes: The most common cause is the natural degeneration of intervertebral discs. It occurs with aging, genetic factors, trauma, and prolonged periods of poor posture and obesity.

Symptoms: Symptoms include back or neck pain, stiffness, and reduced range of motion. Spondylosis is most common in the lower back (lumbar vertebrae) and neck (cervical vertebrae).

Q.35 Describe the course of sciatic nerve. How it gets compressed? Name the disease and describe its symptoms.

Ans. The sciatic nerve is a spinal nerve which starts from the lower lumbar region of spinal cord in the lower back and descends through the buttocks innervating the muscles of each leg.

Causes

- **Herniated disc** or bulging disc, can put pressure on the sciatic nerve, **trauma**, infection, inflammation, and spondylosis resulting into a disease called **sciatica**.
- **Symptoms:** Symptoms include pain or discomfort in the lower back, buttocks, legs or feet, tingling or numbness in the legs or feet, weakness or difficulty moving the legs or feet.

Q.36 Define arthritis. How it show its menifestations?

Ans. Arthritis is the inflammation of joints and includes different inflammatory conditions that affect joints.

Symptoms: Symptoms of include joint pain and stiffness. Other symptoms may include redness, warmth, swelling in affected joints.

Q.37 Characterize Gout.

Ans. Gouty arthritis (or gout) occurs when there is a build-up of **uric acid** in the blood, which can form crystals in the joints and cause inflammation.

- The most common joint affected is the joint of the big toe.
- Other joints (knees, wrists and fingers) may also be affected.

Q.38 What will be your most likely diagnosis of a women of 60 years age presenting with pain in legs, her lab tests

show decreased bone density and low levels of oestrogen? Name the disease and its causes.

Ans.

- It is most probably the case of osteoporosis. Osteoporosis is a condition characterized by weakened bones that are more prone to fractures and breaks. It occurs when bone density decreases, making the bones fragile and porous. Its causes include:
- As people age, bone mass naturally decreases. But it can be more pronounced in some individuals.
- In women, a drop in oestrogen levels after menopause accelerates bone loss. Lack of calcium and vitamin D in the diet can impair bone health.
- Long-term use of corticosteroids, can contribute to bone loss.
- Smoking and alcohol consumption can also increase the risk of osteoporosis.
- Lack of weight-bearing exercise can lead to weakened bones.

Q.39 Define bone dislocation. Write its possible causes and symptoms.

Ans. Bone dislocation is a medical term, which refers to a condition in which the bones in a joint are forced out of their normal positions.

Causes

- This can happen as a result of a sudden impact or trauma. A severe dislocation can cause tearing of the muscles, ligaments and tendons.
- Rheumatoid arthritis can also cause joint dislocation.

Symptoms: Symptoms include swelling, intense pain, and immobility of the affected joint.

- A dislocated joint can only be successfully corrected by a physiotherapist. Surgery may be needed to repair or tighten the stretched ligaments.

Q.40 Define sprain. Write its common points and causes.

Ans. A sprain is an injury to the ligaments that connect bones in a joint. Commonly

injured ligaments are in the ankle, knee and wrist.

Causes

- This can happen when the joint is forced beyond its normal range of motion, causing the ligaments to over stretch or tear.
- Sprains are usually treated with physical therapy. Dressings is done to immobilize the sprain and provide support.

Q.41 A patient presented to you with road side accident suffering from dislocation of his elbow joint and sprain in ankle. How first aid will be given to him?

Ans. First aid treatment for dislocation and sprain includes the following steps.

Immobilize the affected area: Keep the affected area immobile and do not attempt to re-align the dislocated joint. Use a sling or splint to support the limb.

Apply ice: Apply an ice pack or cold compress to the affected area to reduce swelling and pain.

Q.43 Differentiate between smooth and cardiac muscles.

Ans.

Smooth Muscles	Cardiac Muscles
• Smooth muscle fibres are spindle-shaped, have a single nucleus and lack striations. • Smooth muscles are present in the walls of the stomach, intestines, blood vessels, and other internal organs. Because most of their movements cannot be consciously controlled, smooth muscle is referred to as involuntary muscle.	• The muscle fibres of cardiac muscles are striated like skeletal muscle, but each cell usually contains one nucleus located near the centre. • These are found only in the walls (myocardium) of the heart. Their fibres branch extensively.

Q.44 Define sarcolemma, sarcoplasm and SR.

Ans. Sarcolemma

- Each skeletal muscle cell i.e., muscle fibre is a cylindrical multinucleated cell, enclosed by a plasma membrane called **sarcolemma**.

Sarcoplasm

Elevate the affected limb: In the case of dislocation, if possible, elevate the affected limb above to help reduce swelling.

Seek medical attention: Dislocations and sprain require medical attention, so call for emergency medical services 1122 or take the person to the hospital for further evaluation and treatment.

Muscles

★Q42.How mosquito and earthworm employ muscles?

Ans. Muscles' ability to contract and relax not only enables the body to move, but also provides the force that pushes substances, such as blood and food, through the body.

- When a **mosquito** flies, its wings are move rapidly through the air by quickly contacting flight muscles.
- When an **earthworm** burrows through the soil, its movement is driven by strong muscles pushing its body past the surrounding soil.

- Its cytoplasm is called **sarcoplasm**. It has organelles enzymes and glycogen.
- **Sarcoplasmic reticulum (SR)**, SER of skeletal muscles have stored Ca^{++} and no ribosomes.
- The sarcolemma penetrates deep into the cell to form hollow elongated tubes, the **transverse tubules (T-tubules)**. The T-tubules reach the ends of SR.

★Q45. How nerve impulse propagates on a reaching sarcolemma?

Ans. When a nerve impulse reaches sarcolemma, a neurotransmitter (acetylcholine) is released by motor neuron at the synapse. It stimulates the sarcolemma to produce its own electrochemical impulses which are carried into the muscle fibre to the T tubules.

Q.46 Draw the sketch of cardiac muscle.

Ans.

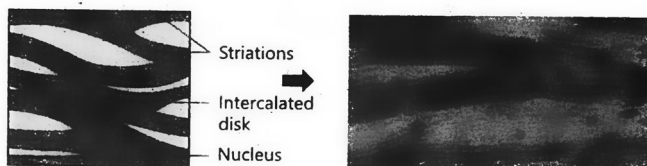


Figure: Cardiac muscles

Q.47 Draw the sketch of ultra-structure of myofilaments.

Ans.

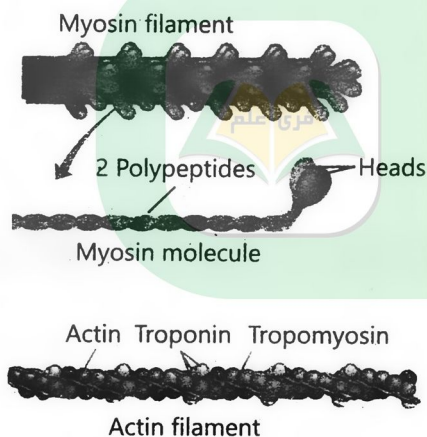


Figure: Structure of myofilament

Q.48 Define cross-bridge and power stroke.

Ans. Cross bridge: When binding sites on actin are exposed, the myosin heads bind to them and form **cross-bridges**.

Power stroke: Once the cross-bridges are formed, the myosin heads release the ADP and P_i , and undergo conformational change. They bend towards the centre of sarcomere, pulling actin filaments with them. This pulling action is called a **power stroke**.

★Q49. Give the summary of structural organization of skeletal muscle.

Ans. A skeletal muscle is made of groups of cells called muscle fibres. Each muscle fibre contains bundles of myofibrils in its cytoplasm. Each myofibril is made of 2 types of myofilaments (myosin and actin).

Q.50 What is sliding filament model? Enlist its steps.

Ans. The sliding filament model explains how a muscle contracts. According to this model, a muscle contracts when its thin myofilaments slide past the thick ones so that they overlap to a greater degree. It occurs in the following steps.

- Sarcomere at relaxed state
- Arrival of nerve impulse
- Cross-bridges and power stroke
- Separation of myosin heads from actin

★Q51. After death, what changes occur in the dead body? / Why does muscles become stiff after death? / What do you know about rigor mortis?

Ans. It is a state of stiffness or rigidity of muscles after death due to ATP deficit, the cells can no longer produce ATP and therefore the cross-bridges cannot be broken. It causes the muscle stiffness of death, or rigor mortis. A living cell, however, always has enough ATP to allow the myosin head to detach from actin.

Q.52 Differentiate between origin and insertion. Write the origin and insertion of quadriceps.

Ans. Typically, a muscle has two attachment points on different bones.

Origin: The end attached to the stationary bone during contraction is called the origin.

Quadriceps: The quadriceps originate at the ilium (part of the pelvic girdle and femur).

Insertion: The end attached to the bone that moves is the insertion. The middle part of the muscle is known as the **belly**.

Example: Insertions at the patella (knee cap) and tibia.

Q.53 Compare flexor with extensor. How they move a bone?

Ans. Flexor: The muscles which bends the bone at joint upon contraction is called flexor e.g., biceps brachii, hamstrings.

Extensor: The muscle which straightens the bone at joint upon contraction is called extensor e.g., triceps brachii, quadriceps.

During such antagonistic action, when a muscle e.g., flexors contracts, the other muscle i.e., extensor is relaxed and vice versa.

Q.54 How does flexion and extension occur at knee-joint? Which muscles are involved in knee-join movements?

Ans. Movement at Knee Joint

The knee joint is located between the femur (thigh bone) and the tibia and fibula (lower leg bones).

Flexion or bending, of the lower leg is done by the hamstrings. It is a group of three muscles at the back of the thigh.

Extension or straightening, of the lower leg is done by the quadriceps. It is a group of four muscles at the front of the thigh.

- When the hamstrings contract, the lower leg bends and the quadriceps relax.
- When the quadriceps contract, the lower leg straightens and the hamstrings relax.

Q.55 Define muscle cramps describe its causes, how it can be relieved?

Ans. Muscle cramps are sudden, involuntary, and often painful contractions of a muscle or group of muscles. They usually last from a few seconds to several minutes and most commonly occur in the legs and feet.

- **Common causes** include dehydration, an imbalance of salts, overuse or injury of the muscle, certain medications (like diuretics), and medical conditions such as diabetes, liver disease, and nerve damage.
- **To relieve muscle cramps**, gently stretch and massage the affected muscle. Applying heat or cold to the area

and using pain-relieving medications can also help.

Q.56 Characterize tetany. Write its causes and treatment.

Ans. Tetany is a condition characterized by involuntary muscle contractions or spasms due to increased muscle tone and hyperexcitability of the nerves. These contractions can occur in various parts of the body such as hands, feet, face, or larynx.

Causes

- The **most common cause** of tetany is **hypocalcaemia** (low level of calcium in blood) which may be due to vitamin D deficiency, renal failure, or thyroid disorders.
- Tetany may also be due to other **salts imbalances**, such as low level of magnesium in blood.
- **Treatment** for tetany depends on the underlying cause. If tetany is caused by salts imbalances, treatment may involve calcium or magnesium supplements or intravenous fluids to restore electrolyte balance.

Q.57 Skeleton is a system of rods and levers. Justify.

Ans. The skeleton works like a system of rods and levers. **Bones** act as the **rods**, giving structure and support to the body and protecting internal organs.

In this system, **joints** serve as **fulcrums** (pivot points) for the levers, allowing movement. **Muscles** generate the **effort** or force, while the weight or resistance being moved is the load.

For example, when lifting a weight, the **bicep** muscle in the upper arm acts as a lever. The **elbow joint** is the **fulcrum**, the bicep provides the effort, and the **weight** is the load.

Q.58 Muscles pull but do not push.

Comment.

Ans. Muscles can only pull, not push. This is because muscle fibres are designed

to contract and shorten, pulling on tendons and thus moving bones. When a muscle contracts, it pulls on the bone via the tendon, and when it relaxes, the bone moves back to its original position.

Muscles cannot push because they only generate force by pulling. If a muscle were

to push, it would need to be attached to bones at both ends and make both ends move closer together, which is not possible in the body. Muscles are usually attached to bone at only one end.

LONG QUESTIONS (EXERCISE)

Q1. Explain the structure of bone.

Ans. See Q1. of theory.

Q2. Describe the structure of three types of cartilage.

Ans. See Q3. of theory.

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

Ans. See Q11. of theory.

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

Ans. See Q12. of theory.

Q5. Describe the three types of muscles.

Ans. See Q15. of theory.

Q6. Explain the ultrastructure of skeletal muscle.

Ans. See Q16. of theory.

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

Ans. See Q18. of theory.

Q8. Explain the action of antagonistic muscles in the movement of knee joint.

Ans. See Q19. of theory.

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

Ans. See Q16. of theory.

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

Ans. See Q20. of theory.

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

Ans. See Q21. of theory.

Q12. Justify why do the muscles pull but do not push.

Ans. See Q22. of theory.

INQUISITIVE QUESTIONS

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

Ans. Role of Ca^{++} in bones

Calcium is the major component of hydroxyapatite ($\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$), the mineralized matrix that gives bones, **hardness** and **strength**, without adequate calcium, bones become weak and porous, leading to increased risk of fractures.

Calcium is also critical in **muscle contraction**, by binding to TnC of Troponin of thin filaments to initiate muscle contraction by excitation contraction-coupling process. Low levels of calcium in blood (hypocalcaemia) leads to tetany (a muscular disorder).

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

Ans. The rigid bones provide the body with strength, support and protection while the joints are compulsory in the sense that primarily they are involved in mobility flexibility.

shock absorbance, reducing energy cost while moving. If our skeleton were a single solid structure, we couldn't have movements along with higher risks for fractures.

Q3. Why do muscles always work in pairs (antagonistic muscles) rather than alone?

Ans. Muscles can't push, they can only pull producing contraction, therefore they must have to work in opposing pairs to enable controlled movements like extension and flexion. If an arm needs to bend at elbow joint, biceps will contract, to straighten the arm there must be a muscle (in this case triceps brachii) to pull in opposite direction. So that's why most of our muscles work in pair with the exception of orbicularis on present around the mouth, which contracts alone rather than in pairs.

Q4. Why does prolonged inactivity or space travel leads to muscle atrophy and bone weakening?

Ans.

- Actually our muscles require mechanical load or stress to maintain its protein synthesis if there is **lack of regular stress** and reduced nervous stimulation, muscles start losing their mass due to prolonged inactivity also in space there is almost zero gravity, our muscles do not work in the absence of gravity which leads to atrophy.
- Likewise bones also remodel and grow in response to stress so during longer periods of inactivity leads to **loss of Ca^{++} by kidneys** which in turn weakens the bones and in space travel under the effect of microgravity, there will be no stress on bones, body starts its demineralization leading to weak bones.



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