

CHAPTER
16**SUPPORT AND MOVEMENT****Key Concepts**

- 16.1 Human skeleton
- 16.2 Disorders of skeleton
- 16.3 Muscles.

EXERCISE**SECTION I: Multiple Choice Questions****Select the correct answer from the following choices.**

1. The atlas and axis vertebrae are located in:
(a) lumbar region (b) cervical region (c) thoracic region (d) pelvic region
2. Hip joint and shoulder joints are examples of:
(a) cartilaginous joint (b) synovial joint
(c) hinge joint (d) ball and socket joint
3. Skeletal muscles contain dark band, which are anisotropic, are called:
(a) A band (b) I band (c) Z band (d) M line
4. The acetabulum provides the articular surface for the:
(a) humerus (b) femur (c) pelvis (d) fibula
5. Scapula is connected with sternum by:
(a) ribs (b) carpals (c) clavicle (d) atlas
6. Which statement correctly describes the smooth muscles?
(a) Unstriated involuntary with spindle shape cells
(b) Unstriated involuntary with multinucleate cells
(c) Unstriated voluntary with uninucleate cells
(d) Striated involuntary with spindle shape cell
7. Thin myofilaments consist of:
(a) actin, myosin, troponin (b) actin, tropomyosin, troponin

8. Which of the following changes occur when skeletal muscle contracts?
 (a) The A-bands shorten (b) The I-band shorten
 (c) The Z-lines move further apart (d) The H-zone becomes more visible
9. A human internal organs are protected mainly by the:
 (a) hydrostatic skeleton (b) axial skeleton
 (c) exoskeleton (d) appendicular skeleton
10. Arm and leg muscles are arranged in antagonistic pairs. How does this affect their functioning?
 (a) it provides a backup if one of the muscles is injured
 (b) one muscle of the pair pushes while the other pulls
 (c) it allows the muscles to produce opposing movements
 (d) it double the strength of contraction
11. Which of the following bones in the human arm would correspond to the femur in the leg?
 (a) radius (b) ulna (c) tibia (d) humerus
12. At the distal end the femur forms knee joint with the proximal end of two parallel bones called:
 (a) tibia and fibula (b) radius and ulna
 (c) carpals and metacarpals (d) tarsal and metatarsal
13. Which of these is mismatched?
 (a) slightly moveable joint-vertebrae (b) hinge joint-hip
 (c) synovial joint - elbow (d) immoveable joint-sutures in cranium
14. The deep infolding of the muscle fibre membrane is called:
 (a) sarcoplasmic reticula (b) Z lines
 (c) T-tubules (d) sarcomeres
15. Bone dissolving cells are called:
 (a) chondrocytes (b) osteoblasts (c) osteoclasts (d) osteocytes
16. Which of the following cartilage in found at the end of long bones?
 (a) calcified (b) fibrous (c) elastic (d) hyaline
17. At times ligaments are overstretched or torn. It is called:
 (a) sprain (b) dislocation (c) fracture (d) tension
18. Which ion is essential for muscle contraction?
 (a) Na (b) K (c) Ca (d) Cl

Answer

1	(b)	2	(d)	3	(a)	4	(b)	5	(c)
6	(a)	7	(c)	8	(b)	9	(b)	10	(c)
11	(d)	12	(a)	13	(b)	14	(c)	15	(c)

SECTION II: Short Questions

Give short answers of the following questions.

Q1. How do compact bone and spongy bone differ in structure?

Answer

In the inner region of bone called endosteum, there are two further regions.

- i) Peripheral part called compact bone.
- ii) Inner bone mass called spongy bone. Most of spongy bone is present in terminal broad parts of bone called epiphysis.

Q2. Name three functions of the bones.

Answer

i) Support and Shape

Bones support soft tissues and serve as attachment sites for most muscles and provide shape to the body.

ii) Protection

Bones protect critical internal organs such as brain, spinal cord, heart, lungs and reproductive organs.

iii) Movement

Skeletal muscles attached to bones help to move the body.

Q3. Which bones form the pectoral girdle?

Answer

Pectoral girdle is composed of three bones:

- i) Scapula
- ii) Clavicle
- iii) Humerus

Q4. List six different types of freely moveable joints?

Answer

- i) Ball & socket joint
- ii) Pivot joint
- iii) Hinge joint
- iv) Saddle joint
- v) Condyloid joint
- vi) Gliding joint

Q5. Name three disorders of human skeleton.

Answer

- i) Slipped disc (Herniation)
- ii) Spondylosis
- iii) Arthritis

Q6. What are the symptoms of arthritis?

Answer

- i) Inflammation of joints.
- ii) Pain after walking which may later occur after even at rest.
- iii) Creaking sounds in joints.
- iv) Difficulty in getting up from chair and pain on walking up and down stairs

Q7. How a broken bone is repaired?**Answer****Repairing Process**

There are four stages in the repairing process which are as follows:

1) Hematoma Formation or Clot Formation

As soon as there is a fracture in bone, the blood vessels of that bone and surrounding are torn which results in hemorrhage. A mass of clotted blood is formed at that place which is called hematoma. After sometime a swelling occurs which creates lot of pain.

2) Fibrocartilaginous Callus Formation

The next step is callus formation which is soft. This takes 3-weeks. The place where hematoma was formed now is provided with capillaries and debris is also cleared. Fibroblast and the bone forming cells osteoblasts now move to that place to form bone.

3) Bony Callus Formation or Callus Ossification

Along with osteoblasts, osteoclasts also move to the place of fracture converting the soft callus into bony callus. After 3-4 weeks of injury bone is formed while 2-3 months is required for firm bony union.

4) Bone Remodelling

After several months, bony callus is remolded by excess material on outside of bone. Final structure of remolded area resembles that of original unbroken bone because it responds to same set of mechanical stimuli.

Q8. What are first-aid treatment for joint dislocation and sprain?**Answer**

- i) A dislocated joint usually can only be successfully "reduced" into its normal position by a trained medical professional. Surgery may be needed to repair or tighten stretched ligament.
- ii) Sprain can be usually treated with treatment such as icing and physical therapy. Dressing, bandages, or ace-wraps should be used to immobilize the sprain and provide support.

Q9. What is remodelling bone?**Answer**

After several months bony callus is remodelled by the excess material on the outside of bone. Final structure of remodelled area resembles that of the original unbroken bone because it response to the same set of mechanical stimuli.

Q10. What changes occur in sarcomere during muscle contraction?**Answer**

In muscle fiber there are alternative dark and light bands. Microscopic study clearly shows that bands are due to regular thick and thin filaments. Transversing the middle of each I-band is a dark line called Z-line.

The section of myofibril between two Z-lines is called sarcomere which is a contractile

sarcomere are found myosin filament.

Q11. Differentiate between bone and cartilage.

Answer

Bone

Bone is a rigid form of connective tissue, which forms the endoskeleton of vertebrates. Bone is a living hard (resists compression) and strong (resists bending) structure. It consists of a hard ground substance or matrix and cells. In the adult human, the matrix consists of about 65% inorganic matter (calcium phosphate, carbonate etc.) and about 35% organic substances (protein, collagen). The cells are embedded in the matrix.

Cartilage

Cartilage is a type of connective tissue consisting of cells called chondrocytes and a tough, flexible matrix made of type II collagen. Unlike other connective tissues, cartilage does not contain blood vessels and the chondrocytes are supplied by diffusion. Because of this, it heals very slowly.

Q12. How thin and thick myofilaments are arranged in myofibrils?

Answer

Ultra Structure of Myofilaent

Thick and thin filament combines to form myofilament. The central thick filament extend the entire length of A band the thin filament extend across the I band and partly into A band. The diameter of thick filament is 16mm. It is composed of myosin. Myosin molecule has tail terminating in two globular heads. Myosin tail consists of two long polypeptide chain coiled together. The head are called cross bridge.

Thin filaments are composed of acting molecules which are 7-8 mm thick. The actin molecules are arranged in two chain which twist around each other like twisted double strand of pearls. Twisting around the actin chains are two strands of protein, tropomyosin. The other major protein in thin filament is troponin.

Q13. You raise your hand to answer a question in class. Example the role played by your bones and skeletal muscles in this movement.

Answer

As we know that skeletal muscles are attached with bones so as to bring the movement. When you want to raise your hand, skeletal muscles contract which result in lifting of bones attached to them. As a result your arm moves up.

Q14. What is the composition of thick and thin filaments?

Answer

Thick Filament

The thick filament which is about 16 mm in diameter is composed of myosin. Each myosin molecule has tail terminating in two globular heads. Myosin tail consists of two long polypeptide chain coiled together. The heads are sometimes called cross bridges because they link the thick and thin myofilaments together during contraction.

Thin Filaments

molecules are arranged in two chains which twist around each other, like twisted double strand of pearls. Twisting around the actin chains are two strands of another protein tropomyosin. The other major protein in thin filament is troponin. It is actually three polypeptides complex (Troponin-T, Troponin-C & Troponin-I). One binds to actin, another binds to tropomyosin while third binds to calcium ions. Each myosin filament is surrounded by six actin filaments on each end.

Q15. Differentiate between tetany and tetanus.

Answer

Tetany

Tetany is a symptom characterized by muscle cramps, spasms or tremors. These repetitive actions of the muscles happen when muscle contract uncontrollably. Tetany may occur in any muscle of the body, such as those in face, fingers or calves. The muscle carmping associated with tetany can be long lasting and painful. A common cause of tetany is very low levels of calcium in the body.

Tetanus

Tetanus is infection of the nervous system with the potentially deadly bacteria *Clostridium tetani*. Spores of the bacteria *C. tetani* live in the soil and are found around the world. In the spore form, *C. tetani* may remain inactive in the soil, but it can remain infectious for more than 40 years. Infection begins when the spores enter the body through an injury or wound. The spores release bacteria that spread and make a poison called tetanospasmin. This poison blocks nerve signals from the spinal cord to the muscles, causing severe muscle spasms. The spasms can be so powerful that they tear the muscles or cause fractures of the spine.

Q16. List the bones that form the pectoral and pelvic girdle.

Answer

Pectoral Girdle

The bones of pectoral girdle consist of:

- i) Ventral coracoids, which meets the sternum
- ii) A scapula
- iii) Clavicle
Lies on ventral side between scapula and sternum.

Pelvic Girdle

Made up of two coxa (coxal bones). Each of these bones is formed by the combination of three bones

- i) Ischium
- ii) Ileum
- iii) Pubis

Q17. Name the bones of cranium and facial skeleton.

Answer

Skull (cranium) Bones

In cranium (skull) there are total 8 bones. Two bones are paired while four are unpaired.

Paired	Unpaired
Parietal	Frontal
Temporal	Occipital
	Sphenoid
	Ethemoid

Facial Bones

There are total 14 bones two are unpaired while six are paired.

Paired	Unpaired
Maxilla	Mandible
Zygomatic	Vomer
Lacrimal	
Nasal	
Inferior Concha	
Palatine	

Q18. Name the bones of Thoracic Cage.

Answer

Rib Cage or Thoracic Cage

In man there are twelve pairs of ribs, one pair articulating with each of the thoracic vertebrae forming a cage that encloses the heart and lungs. Ten pairs of ribs are connected anteriorly with the sternum. Seven pairs out of these ten pairs are directly connected with the sternum and are known as 'true ribs', while the other three pairs are indirectly connected with the sternum through costal arch and are known as 'false ribs'. The lower two pairs of ribs are not attached in front and are known as the "floating ribs".

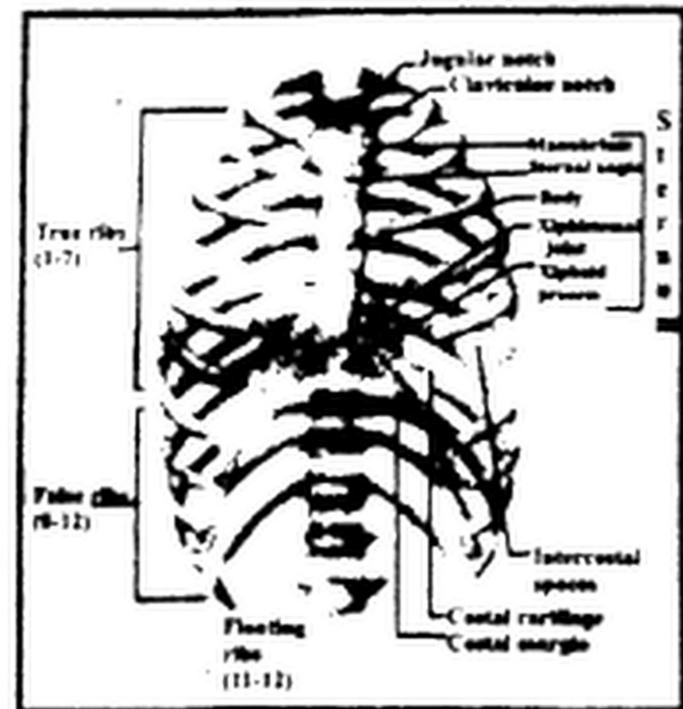


Fig. Human Ribs

Q19. Name the bones of upper and lower limb.

Answer

Hind Limbs

Each hind limb consists of thigh, shank, ankle and foot. In the hind limb there is a single femur in the thigh, a pair of bones, the tibia and fibula, in the shank, 8 anklebones, followed by five longer metatarsals in the foot and finally five rows of fourteen phalanges in the toe.

Forelimbs

lower arm region; 8 carpeis in the wrist and 5 metacarpeis in the palm of the hand and 14 phalanges.

Q20. What are the parts of the vertebral column and what are its curvatures?

Answer

Vertebral Column

Vertebral column extends from skull to the pelvis to form backbone, which protects the spinal cord. Normally the vertebral column has 4 curvatures, which provide more strength than the straight column. The vertebral column consists of 33 vertebrae. The vertebrae are named according to their location in the body, viz., cervical, thoracic, lumbar and pelvic.

Cervical Vertebrae

These are seven vertebrae which lie in the neck region. The first two cervical vertebrae are Atlas vertebra and Axis vertebra.

Thoracic Vertebrae

There are twelve thoracic vertebrae located in the thoracic region.

Lumbar Vertebrae

There are five vertebrae in lumbar region.

Sacrum

Sacrum is formed by the fusion of anterior five vertebrae present in the pelvic region.

Coccyx

Coccyx is formed by the fusion of four posterior vertebrae present in the pelvic region.

Q21. What are the four steps required for fracture repair?

Answer

The repair process of a simple fracture takes place in four phases:

1) Haematoma Formation

When a bone breaks, the blood vessels in the bone itself, and perhaps in surrounding also undergo are torn resulting haemorrhage. As a result a haematoma, a mass of clotted blood, forms at the fracture site. Soon after, bone cell deprived of food begin to die and the tissue at the fracture site becomes swollen and hence painful.

2) Callus Formation

A "soft callus" begins to form in 3-4 weeks. Capillaries grow into the haematoma and clear up the debris. Fibroblasts and osteoblasts migrate into the fracture site and begin to construct bone.

3) Bony Callus Formation

Osteoblasts and osteoclasts continue to migrate inward, multiply rapidly and gradually convert the soft callus into bony callus. Bone formation begins 3 – 4 weeks after injury and continues until a firm bony union is formed within 2 – 3 months later.

4) Remodelling

After several months bony callus is remodelled by the excess material on the outside of the bone. Final structure of remodelled area resembles that of the original unbroken bone because it responds to the same set of mechanical stimuli.

Q22. List the three types of muscle tissues.

Answer

Muscles

Many multicellular animals have evolved specialized cells for movement. These cells contain numerous filaments of special proteins, actin and myosin. The vertebrates possess three kinds of muscle cells; smooth muscles, skeletal muscles and cardiac muscles.



1) Smooth Muscles

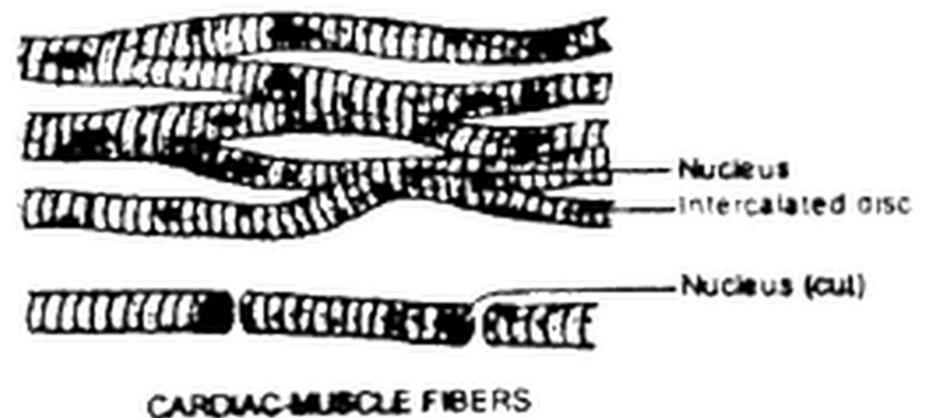
Smooth muscles were the earliest form of muscle to evolve and it is found throughout animal kingdom.

Smooth muscles are long and spindle shaped with each containing a single nucleus. It has no striations. It is not under the voluntary control. We describe smooth muscle tissue most precisely as visceral, non-striated and involuntary. These muscles are found in the blood vessels, Digestive tract and many other organs.



2) Cardiac Muscles

These are muscles of the heart. They constitute most of the mass of the heart walls. Heart muscle is composed of chains of single cell, each with its own nucleus. The chain of cells is organized into fibres that are branched and interconnected. The cardiac muscles are striated and involuntary.



3) Skeletal Muscles

The muscles that are attached with the skeleton and associated with the movement of bones are called skeletal muscles. The skeletal muscles are consciously controlled and therefore are called voluntary muscles. Skeletal muscles are also called striped or striated muscle because they show alternate light and dark bands e.g., triceps and biceps. Generally each end of entire muscle is attached to bone by a bundle of collagen, non-elastic fibres known as tendons.

Q23. List the major parts of a skeletal muscle fibre and write the function of each part.

Answer

The skeletal muscle is attached to the skeleton. The skeletal muscle consists of muscles bundle, which are further composed of huge elongated cells called muscles fibre. These muscles fibres are cylindrical, unbranched and with a diameter of 10 – 100µm.

Each fibre consists of a semi fluid matrix, the sarcoplasm or cytoplasm, containing many nuclei and a large number of mitochondria. The nuclei are located near the periphery of each fibre.

Each fibre is surrounded by a membrane sarcolemma. The sarcolemma of muscle fibre cell penetrates deep into the cell to form hollow elongated tube, the transverse tubule, T-tubule.

The sarcoplasm of the fibre contains many contractile elements called myofibrils, which are 1 – 2µm in diameter. Each myofibril has alternate light and dark bands, which give the fibre its “striped” appearances. It is because of this, that the skeletal muscles are also called striated or striped muscles.

Myofibrils consist of smaller contractile units called sarcomere. In each sarcomere a series of dark and light bands are evident along the length of each myofibril. The dark bands are A band (anisotropic) and the light band are I band (isotropic). Each A band has a lighter strip in its midsection called H-zone (hele for bright) which in turn is bisected by M – line (medial line). The I band have midline called Z – line (zwish meaning between). A sarcomere is the region of a myofibril between two successive Z – line. The region of myofibril is the sarcomere, which is the functional unit of the contraction process in the muscles.

Each myofilament is made up of central thick filament surrounded by thin filament, which are linked together by cross bridges. The thick filament contains a protein, myosin.

Thin filament is composed of a protein actin as its main component besides it also has tropomyosin and troponin proteins. The myosin and actin help in contraction of the muscles.

Thick filament has tail terminating in two globular heads, which are also called as cross bridges and these link thin and thick filaments during contraction.

Q24. What are Z disc and M lines and what are their functions?

Answer

M – Line

Each A band has a lighter stripe in its midsection called H – zone (H stands for “hele” means bright). The H-zone is bisected by dark line called M – line.

Z – Line and Sarcomere

The I bands have mid line called Z – lines (Z for zwish means between). A sarcomere is the region of a myofibril between two successive Z – lines and is the smallest

Q25. How the arrangement of actin filament and myosin filament produce I band, A band and H – Zone?

Answer

Thick Filament

The thick filament which is about 16 mm in diameter is composed of myosin. Each myosin molecule has tail terminating in two globular heads. Myosin tail consists of two long polypeptide chain coiled together. The heads are sometimes called cross bridges because they link the thick and thin myofilaments together during contraction.

Thin Filaments

Thin filaments are 7 – 8 mm thick and composed of chiefly actin molecule. The actin molecules are arranged in two chains which twist around each other like twisted double strand of pearls. Twisting around the acting chains are two strands of another protein, tropomyosin. The other major protein in thin filament is troponin. It is actually three polypeptides complex (Troponin – T, Troponin – C & Troponin – I). One binds to actin, another binds to tropomyosin while third binds to calcium ions. Each myosin filament is surrounded by six actin filaments on each end.

Dark end Light Bands

In each sarcomere a series of dark and light bands are evident along the length of each myofibril. The dark bands are called A band because they are anisotropic that is they can polarize visible light. The light band called I band is isotropic or non-polarizing. This gives the cell as a whole its striped appearance.

H – Zone and M – line

Each A band has a lighter stripe in its midsection called H – zone (H stands for “hele” means bright). The H – zone is bisected by dark line called M – line.

Q26. What is T – tubule system?

Answer

T – System and Triads

The sarcolemma of muscle fibre cell penetrates deep into the cell to form hollow elongated tube; the transverse tubule of T – tubule. The lumen of which is continuous with the extracellular fluid. The thousands of T – tubules of each muscle cell are collectively called T – system. It extends and encircles the myofibril at the level of Z – line or A and I – junction. The T – tubule and terminal portion of the adjacent envelope of sarcoplasmic reticulum form triads at regular interval along the length of the fibril.

Q27. Many old people suffer from osteoarthritis. What skeletal structures are to be the targets for this disease?

Answer

Osteoarthritis is a progressive disease in which the articular cartilages gradually soften and disintegrate. It affects knee, hip and intervertebral joints.

Q28. From your observations describe the changes that occur in bone as

As people become aged, the inflammation of their joints starts which include pain after walking, which may later occur at even at rest, creaking sound in joints and difficulty in getting up from chair and pain on walking up and down stairs.

Q29. What activities and bone functions would be served by the use of metallic artificial joint replacement?

Answer

Artificial joints are usually composed of metal, such as stainless steel, titanium alloys. Activities of such persons whose joints have been replaced by artificial metal plates should be limited to avoid further complications. Such techniques used for replacement of defected joints is called arthroplasty.

Q30. What is meant by a sprained ankle? How does a sprain differ from a strain or dislocation?

Answer

Dislocation of Joints

A dislocated joint is a joint that slips out of place. It occurs when the ends of bones are forced from their normal positions. A severe dislocation can cause tearing of the muscles, ligaments and tendons that support the joint. Symptoms include; swelling, intense pain, and immobility of the affected joint. The most common causes are a blow, fall, or other trauma to the joint. In some cases, dislocations are caused by a disease or a defective ligament. Rheumatoid arthritis can also cause joint dislocation. A dislocated joint usually can only be successfully 'reduced' into its normal position by a trained medical professional. Surgery may be needed to repair or tighten stretched ligaments.

Sprain

A sprain is an injury to a ligament. Commonly injured ligaments are in the ankle, knee and wrist. The ligaments can be injured by being stretched too far from their normal position. The sprain should be rested. Sprains can usually be treated conservatively with treatments such as icing and physical therapy. Dressings, bandages, or ace-wraps should be used to immobilize the sprain and provide support.

Q31. Why are ligaments elastic and why does the tendons needs to be inelastic?

Answer

Ligaments

Collagen fibres & connective tissue fibrils connect bone with bones. These fibrils should be elastic for inducing proper movement of bones. So ligaments can be stretched and gradually lengthen.

Tendons

Collagen fibres and connective tissue fibrils which connect bones with muscles. Tendons are less elastic in nature as compared to ligament, so that muscles could remain close to bones for pulling of bones effectively.

Q32. Why do cartilage generally wear out the joints?

Many sprinters feel they have to keep low and pull to run fast. The human body is built to push, not pull. If you stay relaxed and upright and push against ground, you will run faster. So this pushing action can easily be done by toes.

Q33. Relate improper posture to bone/joint problems.

Answer

Improper posture causes stress on joints and their supporting structures resulting in injury, pain and early degradation of bones and joints.

Q34. Draw a diagram of sarcomere and label its parts.

Answer

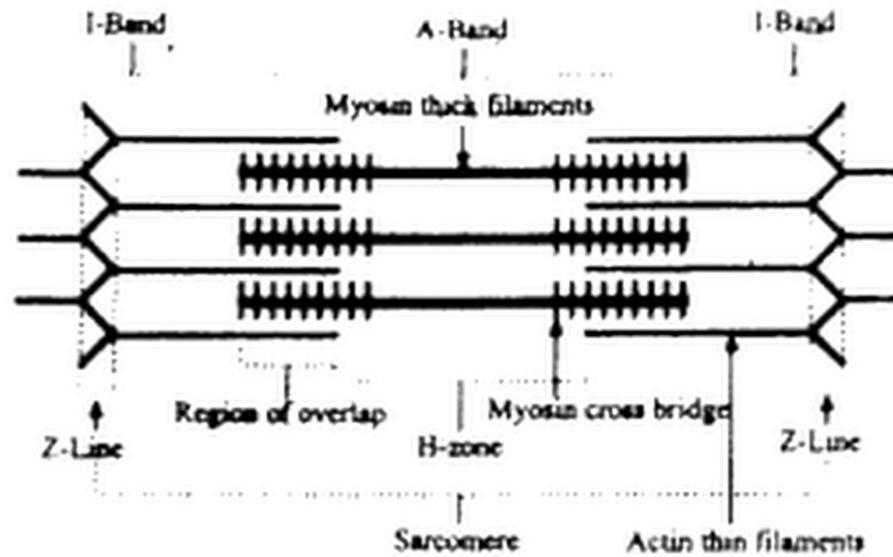


Fig. Composition of sarcomere

Q35. Write the differences between tetany and tetanus.

Answer.

Tetany

The insufficient parathyroid hormone production causes a significant drop in the blood calcium level, tetany results. In tetany, the body shakes from continuous muscle contraction i.e., muscle, twitches and convulsion occurs. Tetany results in the excitability of neurons and results in loss of sensation. If untreated the system progress to spasm of larynx, paralysis and ultimately death occurs.

Table 16.3 Difference between Tetany and Tetanus	
Tetany	Tetanus
Caused by low calcium level in blood.	Caused by infection of <i>Clostridium tetani</i> .
Results in the excitability of neurons and results in loss of sensation.	Due to severe convulsion the patient dies due to lack of oxygen.

SECTION III: Extensive Questions

Q1. Describe the structure of bone and compare it with that of cartilage.

Answer

Structure of Bone

An individual bone is composed of a variety of tissues, including bone tissue, cartilage, fibrous connective tissue, blood and nerve tissue. The terminal broad parts are called epiphysis and the middle part along the length of bone is called diaphysis or shaft which also contains a central cavity (lumen) filled yellow bone marrow. The outer connective tissue around the bone is called periosteum and the inner region is called endosteum. The endosteum further consists of a peripheral part, called compact bone and the inner bone mass, called spongy bone. Most of the spongy bone is present in epiphysis. The red bone marrow is also found in the spaces of spongy bone (Fig. 16.2).

There are three types of cells associated with bone (derived from osteogenic cells) i.e., osteoblasts are bone forming cells that synthesize and secrete unmineralized ground substance. Once the osteoblasts are surrounded by matrix, they become the osteocytes. Osteocytes maintain healthy bone tissue by secreting enzymes and influencing bone mineral content. They also regulate the calcium release from bone tissue to blood. Osteoclasts are bone destroying cells. Osteoclasts perform bone resorption (demineralization), i.e., they breakdown bone and deposit calcium and phosphate in the blood. The work of osteoclasts is important to the growth and repair of bone (Fig. 16.1).

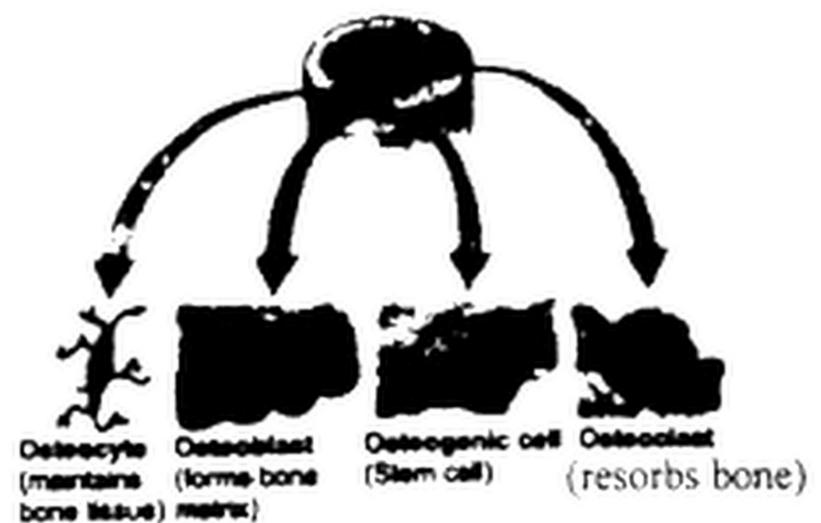


Fig. Types of cells

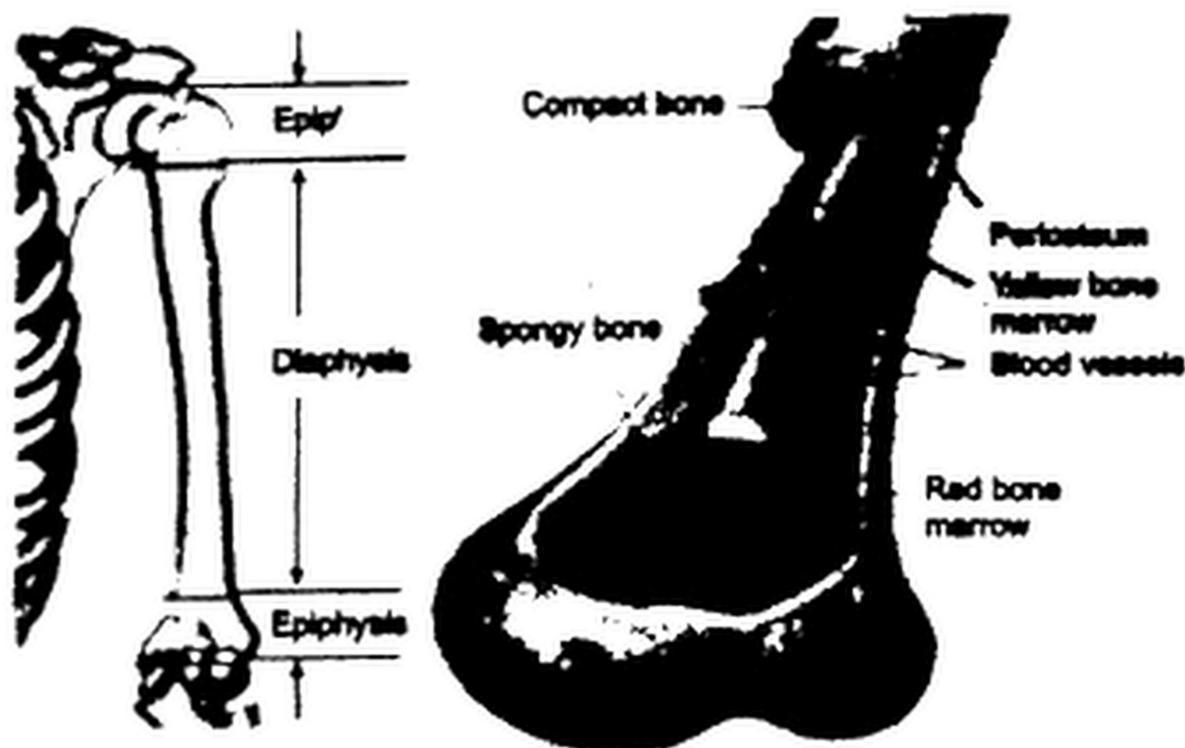


Fig. Structure of bone

than the bone because the matrix is gel like and contains many collagenous and elastic fibres. The cartilage matrix is covered by a dense layer of collagen fibres, called perichondrium. There are many small cavities distributed in the matrix called lacunae which contain cartilage cells. The living cells of cartilage are called chondrocytes. Unlike other connective tissues, cartilage does not contain blood vessels and the chondrocytes are supplied by diffusion. Because of this, it heals very slowly. Although the human skeleton is initially made up of cartilages fibrous membranes, most of these early supports are soon replaced by bones. A few cartilages that remain in adults are of three types. Hyaline cartilage is found at the ends of long bones and in the nose, at larynx and trachea. Fibrocartilage contains wide rows of thick collagenous fibres is found in the disks located between the vertebrae, cartilage of



Fig. 16.3 Structure of cartilage

Feature	Bone	Cartilage
Collagen	Densely packed	Loosely packed
Cell types	Osteoblast, osteocytes and osteoclasts	Chondrocytes
Blood vessel	Present	Absent
Minerals	Deposit minerals such as calcium, carbonates, phosphates, etc.	No deposition of minerals
External covering	Covered by periosteum	Covered by perichondrium

Q2. Describe the bones of appendicular and axial skeleton of man.

Answer

Divisions of Human Skeleton

Human skeletal system consists of 206 bones which are primarily divided into two divisions i.e., axial skeleton and appendicular skeleton (Fig. 16.4).

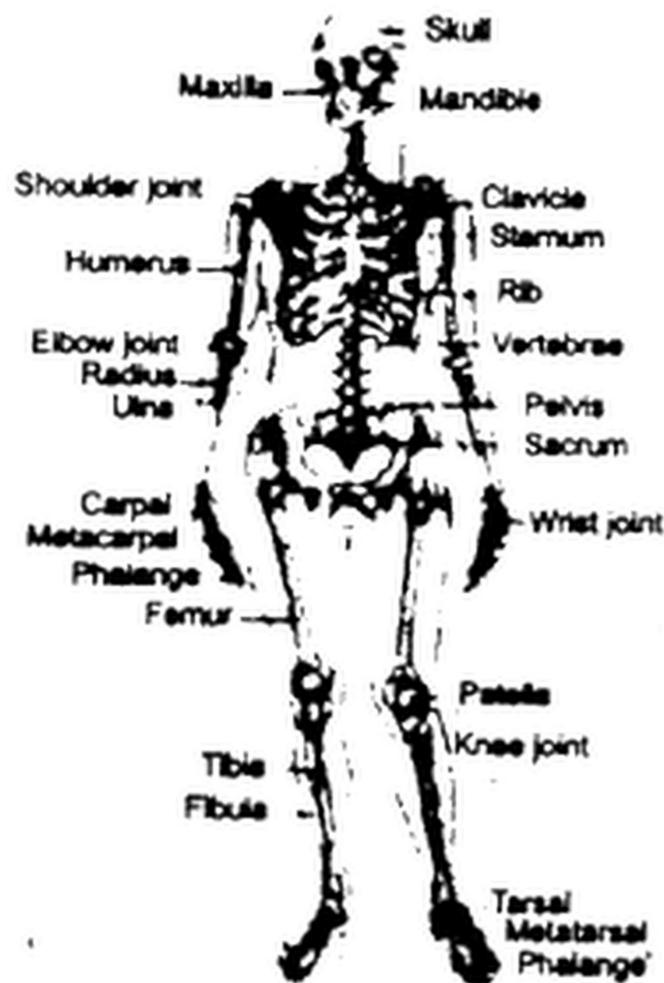


Fig. Human skeleton

Axial Skeleton

Axial skeleton includes those skeletal parts which are present along the central axis of the body, like skull, vertebral column and rib cage.

Head Bones

Head contains 29 bones which are divided into four divisions i.e., cranial bones, facial bones, ear ossicles and hyoid bone. Cranial bones form cranium (brain box). Out of 8 cranial bones two are paired i.e., parietal bones (left and right) and temporal bone (left and right) while four are unpaired like frontal bone, occipital bone, ethmoid bone, sphenoid bone. Facial bones are fourteen in number and are attached to the cranium to form face. The six paired bones of face are: lacrimal, zygomatic, nasal bones, inferior nasal concha, maxilla and palatine. The unpaired bones of face are mandible and vomer.



Fig. Human skull (side view)

Ear ossicles are the six bones found in ears. These are incus (left and right), malleus (left and right) and stapes (sta – peeze) (left and right). 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.

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

Rib Cage

The rib cage consists of twelve pairs of ribs. The ribs articulate posteriorly with the thoracic vertebrae. Ten ribs are connected anteriorly with sternum either directly or through the costal cartilage. The rib cage provides support for a semi-vacuum chamber called chest cavity. The seven pairs of ribs that attach directly to the sternum are called true ribs. The 8th, 9th and 10th are called false ribs, as these three pairs of ribs are attached to the sternum by means of common costal cartilage. 11th and 12th pairs of ribs are known as floating ribs, because they do not attach to the sternum.

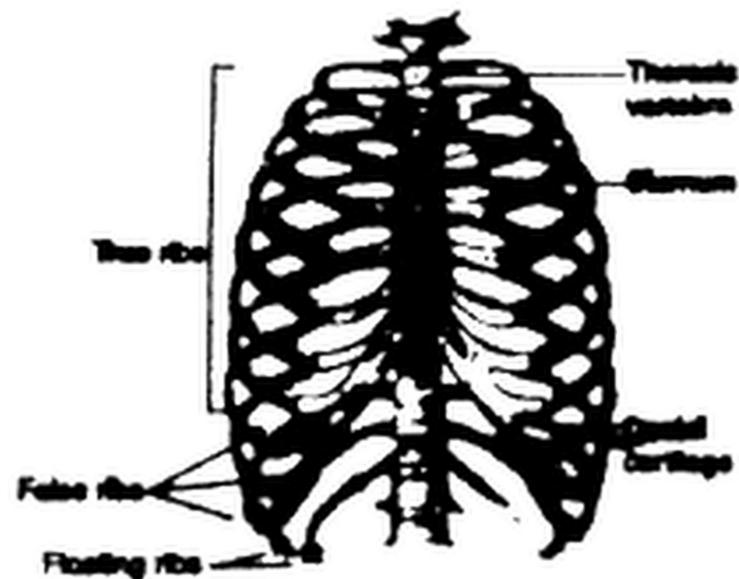


Fig. Human rib cage

Appendicular Skeleton

Appendicular skeleton includes those skeletal parts which are present in appendages (arms and legs). These are pectoral girdle, pelvic girdle, forelimbs and hind limbs.

Upper Limb and Pectoral Girdle

Pectoral girdle consists of a pair of clavicles and a pair of scapula. Clavicles are a pair of collar bones. One end of each curved bone articulates with the sternum. The other

phalanges. Humerus is a long bone, the end of which has a spherical head, which fits into the glenoid cavity; Radius is a long, outer bone of the forearm (on the thumb side). Ulna is along bone on the inner side of the forearm, and slightly bigger than radius. Carpals consists of two rows of eight short bones forming the wrist. The upper row articulates with the radius and forms the wrist joint. Metacarpals consist of five bones making up the palm of the hand. Each finger possesses three phalanges except thumb which comprises two.

Lower Limb and Pelvic Girdle

The pelvic girdle is made up of three units the ileum, ischium and pubis which form coxa. The two halves of the pelvic girdle are joined at the pubic symphysis. A cavity called acetabulum is also present.

Lower limb or Hind limb consists of femur, patella, tibia, fibula, tarsal, metatarsal and phalanges. Femur or the thighbone is a long bone with head, which fits into the acetabulum. Patella or the kneecap is embedded in a long tendon which runs over the knee joint. Tibia or shin bone is the large bone in the leg. Fibula or outer bone is a thin bone joins the tibia just below the knee joint and just above the ankle. Tarsal is made of seven bones which are tightly attached to form the ankle. Metatarsal consists of five bones which articulate with the tarsal and phalanges to form the sole of the foot. Phalanges are small bones which make up the toes. Each toe of the foot possesses three phalanges except great toe, which comprises two.

Q3. How the joints are classified? Give examples of the different types of synovial joints and the movement they permit.

Answer

Joints

A joint or articulation is a place where two bones or bone and cartilage come together. The scientific study of the structure and function of joints is called arthrology. The joints are classified as fibrous joints (immoveable), cartilaginous joints (slightly moveable) and synovial joints (freely moveable).

Fibrous Joints

They firmly bind skeletal elements together with fibrous connective tissue. The three kinds of fibrous joints are sutures, syndesmoses and gomphoses. Sutures are characterised by a thin layer of dense irregular connective tissue that binds the articulating bones. Sutures are found only within skull. Syndesmoses are fibrous joints held together by fibrous tissue. This type of joint occurs in the middle ear chamber and between the distal parts of the radius and ulna. Gomphoses are fibrous joints that occur between the teeth and supporting bones of the jaw.

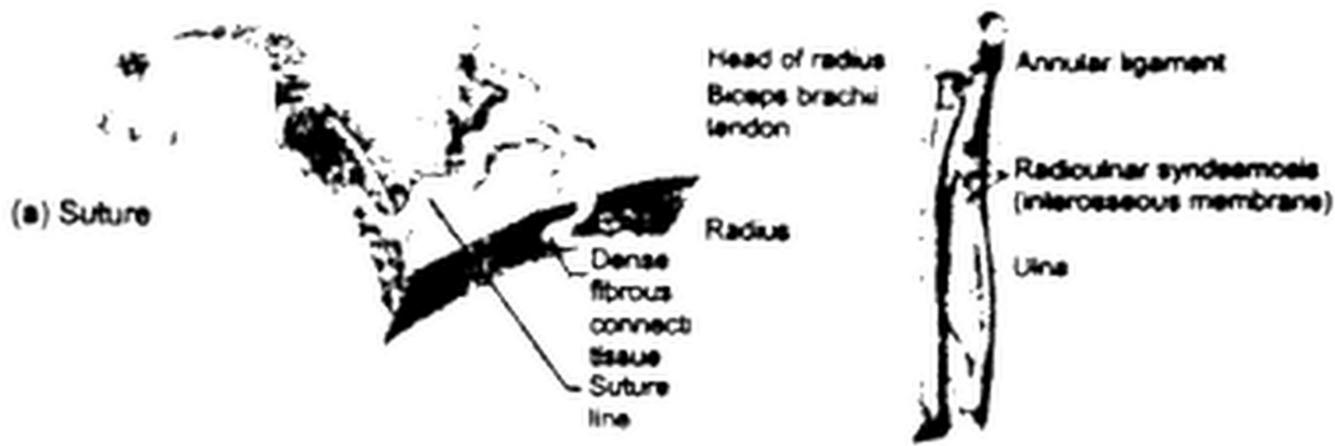
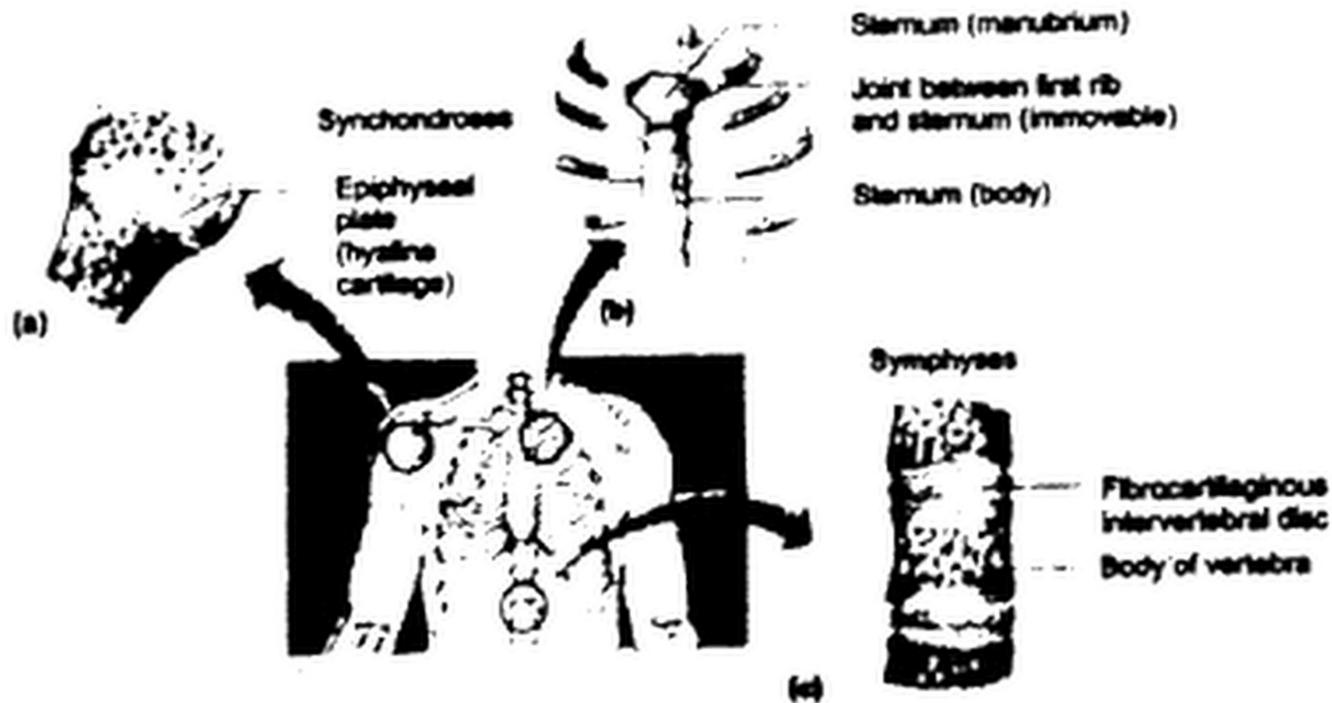


Fig. Types of fibrous joints (a) structures of skull (b) syndesmosis of radius and ulna

Cartilaginous Joints

In these joints bones are held together by cartilage. The two types of cartilaginous joints are symphyses and synchondroses. The adjoining bones of symphyses are covered with hyaline cartilage. It cushions the joint and allows limited movement e.g., symphysis pubis and the intervertebral joints. Synchondroses are cartilaginous joints that have hyaline cartilage between the articulating bones e.g., the costal cartilages that attach ribs to the sternum.



Types of cartilaginous joints (a and b) synchondroses (c) symphyses

Synovial Joints

They are freely moveable joints. The ends of bones are covered with hyaline cartilage and held together by a surrounding, tube like capsule of dense fibrous tissue. The joint capsule is composed of an outer layer of ligaments and an inner lining of synovial membrane, which secretes synovial fluid (Fig. 16.10).



Types of Synovial Joints

Hinge Joint

The convex surface of one bone articulates with the concave surface of another. Up-and-down motion in one plane is possible. Examples: The elbow and knee joints (Fig a).

Pivot Joint

A small, cylindrical projection of one bone pivots within the ring formed of bone and ligament of another bone. Only rotation is possible. Examples: The joint between the proximal ends of the radius and ulna, and the joint between the atlas and axis (Fig b).

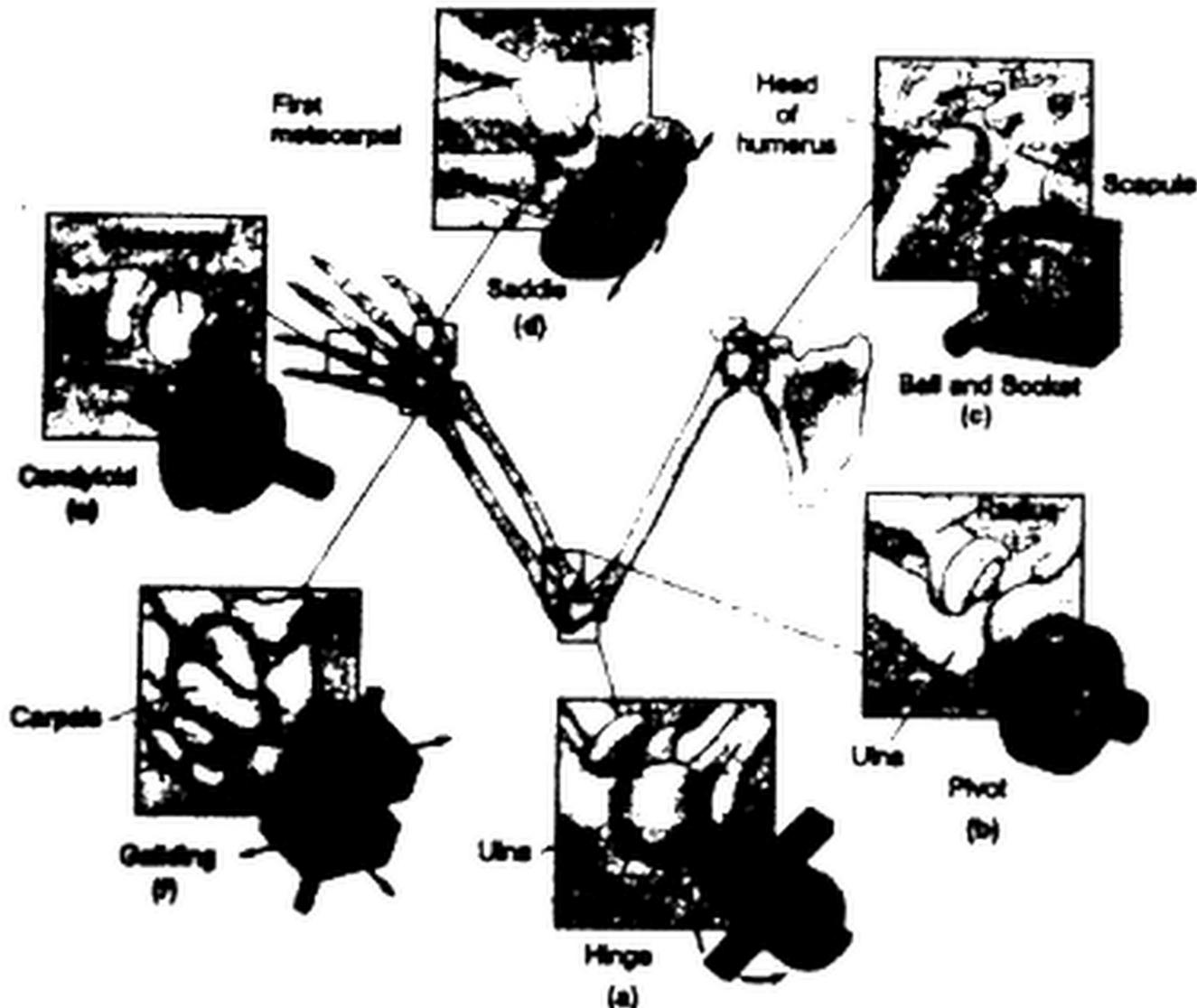


Fig. Types of synovial joints

Ball-and-Socket Joint

The ball-shaped head of one bone fits into the cup-shaped socket of another. Movement in all planes, as well as rotation, are possible. Examples: The shoulder and hip joints (Fig c).

Saddle Joint

Each bone is saddle-shaped and fits into the complementary regions of the other. A variety of movements are possible. Example: The joint between the carpal and metacarpal bones of the thumb (Fig d).

Condyloid Joint

The oval-shaped condyle of one bone fits into the elliptical cavity of another. Movement in different planes is possible, but rotation is not. Example: The joints

Gliding Joint

Flat or slightly curved surfaces of bones articulate. Sliding or twisting in various planes is possible. Example: The joints between the bones of the wrist and between the bones of the ankle (Fig f).

Q4. Relate the bipedal posture of man with its skeleton and musculature.

Answer

Curvatures of vertebral column help to balance the body for bipedal stance. The intervertebral discs lend flexibility to vertebral column and absorb vertical shocks. The structure of pelvis, in its attachment to the vertebral column, permits upright posture and locomotion on two appendages (bipedal locomotion).

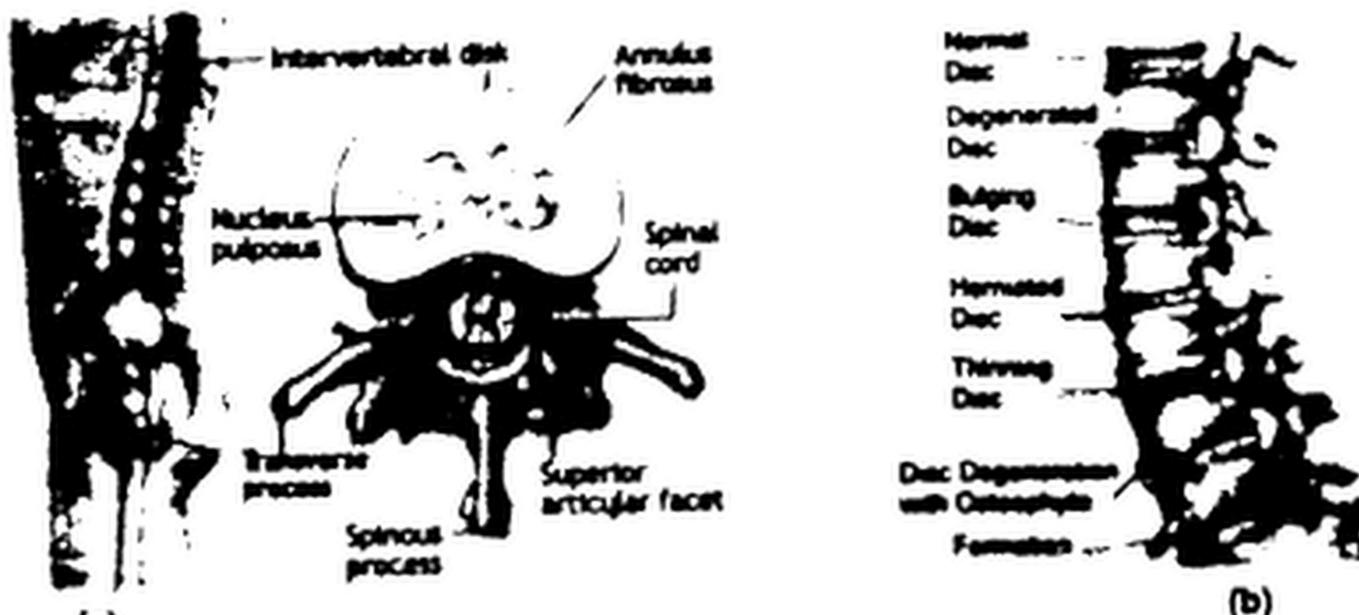
Certain muscles are active posture muscles whose primary function is to work in opposition to gravity. For example, the strong, complex muscles of vertebral column are adapted to provide support and movement in resistance to the effect gravity. Thus, the skeleton and muscular systems maintain the bipedal posture of man.

Q5. Write notes on disc slip, spondylosis, sciatica, arthritis, muscle fatigue, cramp and tetany.

Answer

Slipped Disc

Each intervertebral disc is a cushion like pad which consists of nucleus pulposus and annulus fibrosus. Nucleus pulposus is an inner semifluid which acts as a rubber ball to give a disc its elasticity and compressibility. Annulus fibrosus is the strong outer ring of fibrocartilage, which holds together successive vertebrae. The discs act as shock absorber. Severe or sudden trauma to spines may result in herniation of one or more discs (16.12a). The herniated disc or slipped disc usually involves rupture of annulus fibrosus followed by protrusion of the spongy nucleus pulposus. If protrusion presses on spinal cord or on spinal nerves, generate severe pain or even destruction of these nervous structures. 'slipped disc' is misleading as it is not the whole disc that slides out of the position (Fig. 16.12 b).



Spondylosis

It is the immobility and fusion of vertebral joint. Cervical spondylosis results from chronic cervical degeneration, with herniation of disc and aging.

Sciatica

Sciatica refers to pain, weakness, numbness, or tingling in the leg. It is caused by injury to or pressure on the sciatic nerve. Common causes of sciatica include: slipped disc, pelvic injury or fracture and tumors.

Arthritis

It is the inflammation of joints. The typical symptoms of arthritis include pain after walking which may later occur even at rest, creaking sounds in joint, difficulty in getting up from a chair and pain on walking up and down stairs. There are different types of arthritis. Osteoarthritis is a progressive disease in which the particular cartilages gradually soften and disintegrate. It affects knee, hip and intervertebral joints.

Rheumatoid arthritis is the result of an autoimmune disorder in which synovial membrane becomes inflamed due to faulty immune system. Gouty arthritis results from a metabolic disorder in which an abnormal amount of uric acid is retained in the blood and sodium urate crystals are deposited in the joints. The most common joint affected is the joint of the big toe.

Muscle Fatigue

When the muscles lose the ability to contract, the physiological state of muscle is called muscle fatigue.

ATP is needed for muscle contraction. When there is no ATP, the cross bridges cannot detach as a result of contractures i.e., state of continuous contractile results. The other factors which contribute to muscle fatigue are accumulation of lactic acid and ionic imbalance. The cause of extreme fatigue is lactic acid which causes muscle pH to drop and the muscle to ache by breaking glucose.

Cramp

It is also known as tetanic contraction of entire muscle. It lasts for just few seconds to several hours, causing the muscle to become taut (tightly drawn) and painful. It is most common in thigh and hip muscles. It usually occurs at night or after exercise. It reflects low blood sugar level, electrolyte depletion, dehydration, irritability of spinal cord and neurons.

Tetany

The insufficient parathyroid hormone production causes a significant drop in the blood calcium level, tetany results. In tetany, the body shakes from continuous muscle contraction i.e., muscle, twitches and convulsion occurs. Tetany results in the excitability of neurons and results in loss of sensation. If untreated the system progress to spasm of larynx, paralysis and ultimately death occurs.

c) Describe the first aid treatment of bone fracture.

Answer

a) Bone Fractures

A fracture is the medical term for a broken bone. They occur when the physical force exerted on the bone is stronger than the bone itself. So bones break when they cannot withstand a force or trauma applied to them.

Common Types of Fractures

Simple fracture or closed fractures are those in which the skin is intact. If the bone ends penetrate the skin and form a wound is called compound fracture or open fracture. When a fracture damages the adjacent organs it is called complicated fracture.



Fig. Bone fracture

b) Bone Repair

Bone is a living tissue that undergoes repair following fracture. The repair process of a simple fracture takes place in four major steps.

Hematoma or Clot Formation

When a bone breaks, blood vessels in the bone, and perhaps in surrounding tissues, are torn and hemorrhage. As a result, a hematoma, a mass of clotted blood, forms at the fracture site. Soon, bone cells deprived of nutrition die, and the tissue at the site becomes swollen, painful, and inflamed.

Fibrocartilaginous Callus Formation

Within a few days, several events lead to the formation of fibrocartilaginous or soft callus. Capillaries grow into the hematoma and phagocytic cells invade the area and begin cleaning up the debris. A fracture ruptures the periosteum and stimulates the production and release of the numerous osteoblasts. These osteoblasts in conjunction with cartilage forming cells secrete a porous mass of bone and cartilage called callus (or cartilaginous callus) surrounding the break. The callus replaces the original blood clot and holds the ends of the bones together. This process takes 3-4 weeks.

Bony Callus Formation or Callus Ossification

Within a week, after the formation of soft callus, it is gradually converted into a hard bony callus of spongy bone. Bony callus formation continues until a firm union is formed about two months later. Osteoclasts breakdown the cartilage while osteoblasts replace it with bone.

Bone Remodelling

It takes place when a compact bone is formed in which the osteons from both sides break extend across the fracture line to connect the bone. Usually, more bone is produced at the site of a healing fracture than needed to replace the damaged tissue. However, osteoclasts eventually remove the excess and the final result of the repair is bone shaped very much like the original. The final structure of the remodelled area



Fig. Bone repair

c) First Aid Treatment for Disorder of Skeleton (bone fracture)

Prompt and proper first aid increases the chances of a complete recovery. Usually, the severity of the bone fracture and dislocation of joints depends on its cause and the affected part. If you suspect someone has dislocated a joint or fractured bone, you can help by: (a) immobilizing the fractured bone or dislocated joint but do not attempt to manipulate, pull or re-align the injured joint or bone. Leave this task to a professional. (b) If possible; apply ice pack or cold pack over the affected part to reduce swelling. (c) Assist the victim to position of comfort. (d) Provide support to the affected area such as using sling or splints. Listen to what the victim tells you. (e) Dislocations involving the hip, ankle and leg joints and compound fractures require ambulance to transport the victim.

Q7. Describe injuries in joints and their first aid treatment.

Answer

Joint Injuries

Joint Dislocation

A dislocated joint is a joint that slips out of place. It occurs when the ends of bones are forced away from their normal positions. When a joint is dislocated, it no longer functions properly. A severe dislocation can cause tearing of the muscles, ligaments and tendons that support the joint. Symptoms include: swelling, intense pain, and immobility of the affected joint. The most common causes are a blow, fall, or other trauma to the joint. In some cases, dislocations are caused by a disease or a defective ligament.



Fig. Ligaments in the ankle.

Rheumatoid arthritis can also cause joint dislocation. A dislocated joint usually can only be successfully 'reduced' into its normal position by a trained medical professional. Surgery may be needed to repair or tighten stretched ligaments.

Sprain

A sprain is an injury to a ligament. Commonly injured ligaments are in the ankle, knee, and wrist. The ligaments can be injured by being stretched too far from their normal

prevent abnormal movements. However, when too much force is applied to a ligament, such as in a fall, the ligaments can be stretched or torn. The sprain should be rested. Sprains can be usually treated with treatments such as icing and physical therapy. Dressings, bandages, or ace-wraps should be used to immobilize the sprain and provide support.

First Aid Treatment for Disorder of Skeleton

Prompt and proper first aid increases the chances of a complete recovery. Usually, the severity of the bone fracture and dislocation of joints depends on its cause and the affected part. If you suspect someone has dislocated a joint or fracture bone, you can help by: (a) immobilizing the fractured bone or dislocated joint but do not attempt to manipulate, pull or re-align the injured joint or bone. Leave this task to a professional (b) If possible; apply ice pack or cold pack over the affected part to reduce swelling. (c) Assist the victim to position of comfort. (d) Provide support to the affected area such as using sling or splints. Listen to what the victim tells you. (e) Dislocations involving the hip, ankle and leg joints and compound fractures require ambulance to transport the victim.

Q8. Compare three types of muscles of man.

Answer

There are three types of muscle tissues: smooth, cardiac and skeletal.

Smooth Muscles

These are distributed widely throughout the body and are more variable in function than other muscle types. The smooth muscle cells are spindle shaped, with a single nucleus located in the middle of the cell. Myofilaments are not organised into sarcomeres. Consequently, smooth muscle does not have a striated appearance. Smooth muscle cells contain non-contractile intermediate filaments. Smooth muscles are involuntary in function. They are found in digestive, reproductive, urinary tract, blood vessels etc., (Fig. 16.15 a).



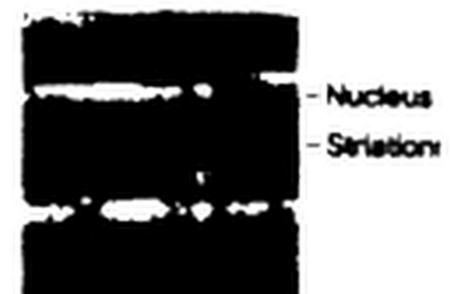
(a) Smooth muscles



(b) Cardiac muscles

Cardiac Muscles

These are found only in heart. They branch extensively. Cardiac muscles are striated like skeletal muscle, but each cell usually contains one nucleus located near the centre. Adjacent cells join together to form branching fibres by specialised cell-to-cell attachments called intercalated discs, which have gap like junctions that allow action potentials to pass from cell to cell (Fig. 16.15 b).



Skeletal Muscles

movement (locomotion).

Property	Smooth Muscles	Cardiac Muscles	Skeletal Muscles
Muscle appearance	Unstriped	Irregular striped	Regular striped
Cell shape	Spindle	Branched	Spindle or cylindrical
Number of nuclei	One per cell	One per cell	Many per cell
Speed of contraction	Slow	Intermediate	Slow to rapid
Contraction caused by	Nervous system	Spontaneous	Nervous system
Function	Controls movement of substances through hollow organs	Pumps blood	Move skeleton
Voluntary control	Usually no control	Usually no control	Have control

Q9. Explain the ultra structure of skeletal muscle.

Answer

Structure of Skeletal Muscles

Skeletal muscles or striated muscles show alternate light and dark regions under microscope. Externally muscle is covered in a connective tissue wrapping called epimysium. Each skeletal muscle consist of hundreds to thousands of muscles fibres (muscle cells). Each muscle is divided into discrete bundles of muscle cells called fascicles. The fascicle is surrounded by perimysium. Each muscle fibre within the fascicle is covered by a layer of connective tissue called the endomysium which is present outside the sarcolemma (plasma membrane of the muscle fibre). Skeletal muscles are composed of muscle fibres or muscle cells. Each skeletal muscle fibre is a single cylindrical cell, enclosed by a plasma membrane like structure called sarcolemma and has several nuclei. The sarcolemma of muscle fibre cell penetrates deep into the cell to form a hollow elongated tube the transverse tubule (T-tubule). Within the muscle fibres are numerous thin myofibrils (myo, muscle, fibra, thread) which possess characteristic cross striations (Fig. 16.16).

The myofibrils are 1-2 μm in diameter that run in parallel fashion and extend the entire length of the cell. Each myofibril is composed of two types of myofilaments (or microfilaments) actin and myosin. The cytoplasm of the myofibril is called sarcoplasm. It contains sarcoplasmic reticulum.

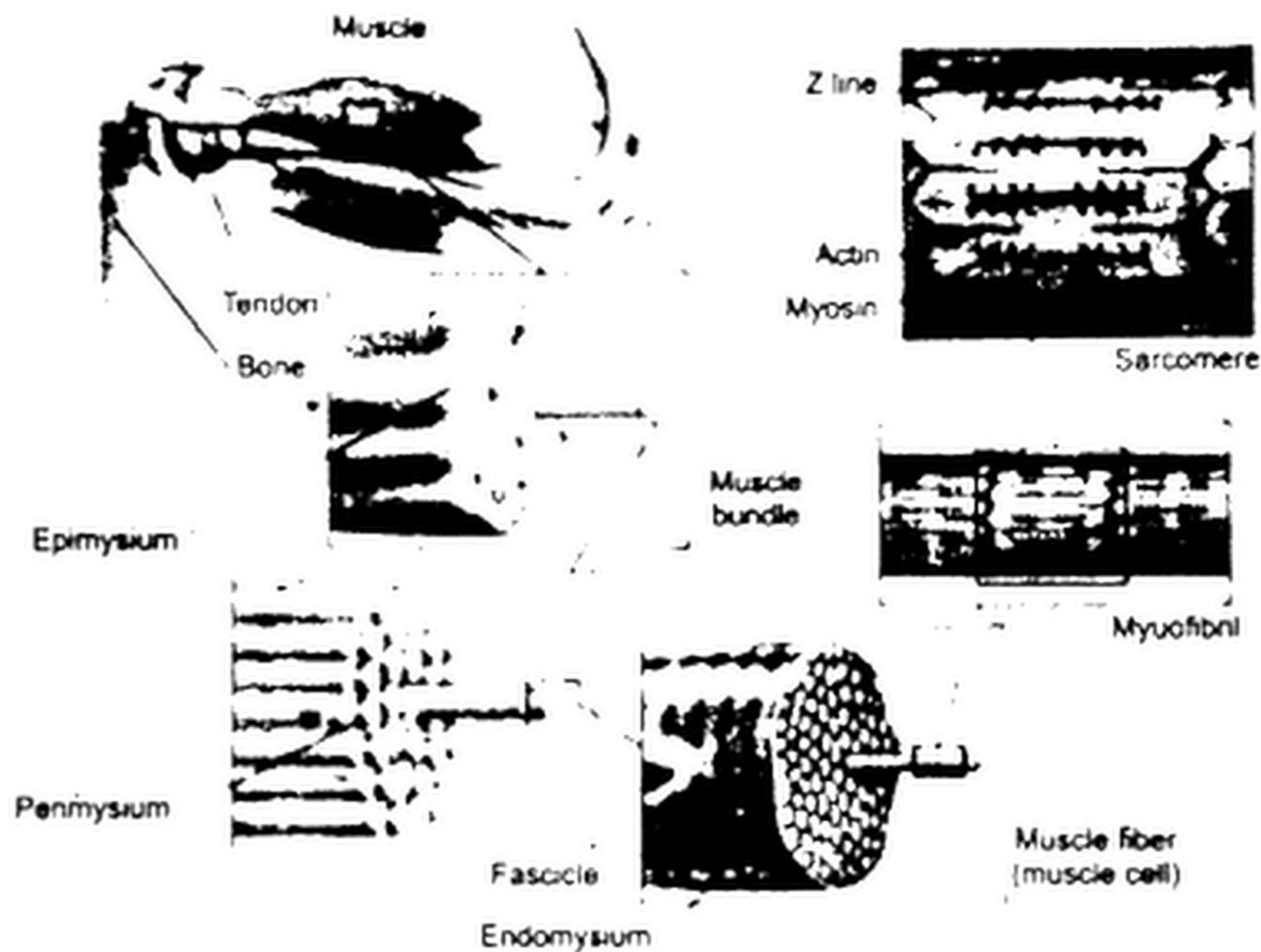


Fig. Structure of skeletal muscle

Muscle fibres range from approximately 1mm to about 4cm in length and from 10 – 100 μm in diameter. All the muscle fibres in the given muscle have similar dimensions. Bundles of muscle fibres are enclosed by collagen fibres and connective tissue. At the ends of the muscle the collagen and connective tissue forms tendons which attach the muscle to skeletal elements.

Under a light microscope only the striated nature of the myofibrils can be observed. This is seen as a regular alternation of light and dark bands called the I bands and A bands respectively, transverse by thin, dark lines. Electron microscope studies clearly indicated that the bands are due to regular arrangement of thin filaments and thick filaments. Transversing the middle of each I band is a dark line called the Z line (Z for *zwischen*, a German word meaning 'between discs'). The section of myofibril between two Z lines is called a sarcomere, which is a contractile unit. From the Z line actin filaments extend in both directions, whilst in the centre of the sarcomere are found myosin filaments.

Ultra-Structure of Skeletal Muscles

In certain regions of the sarcomere, actin and myosin filaments overlap. Transverse sections in these regions indicate that six actin filaments surround each myosin filament. This arrangement of actin and myosin filaments result in a number of other bands being recognizable in the sarcomere. Myosin and actin filaments constitute the A band because they are anisotropic that can polarize visible light. Actin filaments alone constitute I band, which are isotropic or polarizing. The centre of the A band is lighter

The H zone itself may be bisected by a dark line, the M line. The M line joins adjacent myosin filaments together at a point halfway along their length.

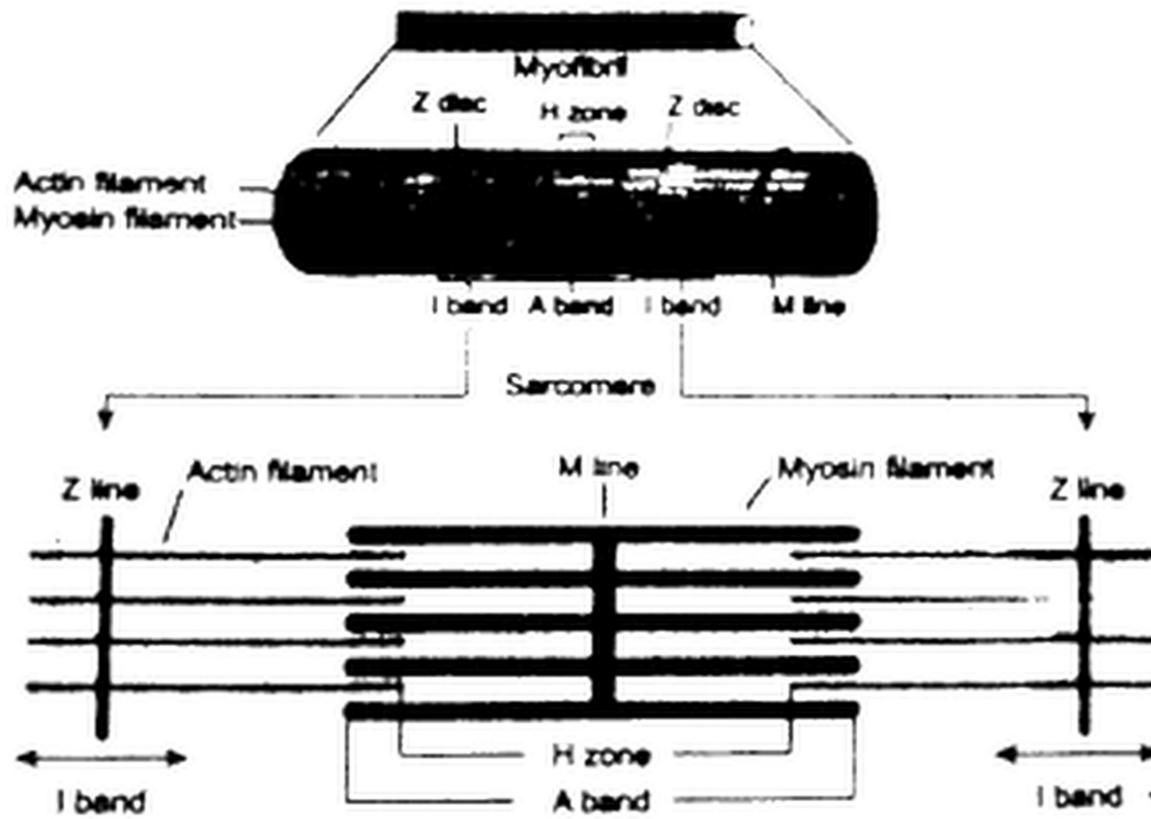


Fig. The ultra structure skeletal muscle

Thick myofilaments are 16nm in diameter and are composed of only myosin protein. Each myosin molecule consists of six polypeptides which are arranged in such a way that each myosin molecule possesses a tail and two globular heads. Each thick filament contains about 300 myosin molecules bundled together with their tails forming the central part of the thick filament and their heads facing outward and in opposite directions at each end.



(a) Myosin molecule region



(b) Portion of thick filament



Fig. Actin filament

The thin filaments are 7-8 nm thick and are composed chiefly of the actin protein. The kidney-shaped polypeptide subunits of actin, called globular actin or G actin, bear the active sites to which the myosin heads attach during contraction. G actin monomers are polymerized into long actin filaments called fibrous, or F actin. The backbone of each thin filament appears to be formed by two intertwined actin filaments that look like a twisted double strand of pearls.

bind to the thin filaments. Troponin is a three-polypeptide complex. One of these polypeptides (TnI) is an inhibitory subunit that binds to actin; another (TnT) binds to tropomyosin and helps position it on actin. The third (TnC) binds calcium ions. Both troponin and tropomyosin help control the myosin-actin interactions involved in contraction.

Q10. Explain the sliding filament model of muscle contraction.

Answer

Muscle Contraction Sliding Filament Model

The sliding filament theory of contraction states that during contraction the thin filaments slide past the thick ones so that the actin and myosin filaments overlap to a greater degree. In a relaxed muscle fibre, the thick and thin filaments overlap only at the ends of the A band. But when muscle fibres are stimulated by the nervous system, the myosin heads are attached on to myosin binding sites on actin in the thin filaments, and the sliding begins. These links are called cross bridges which are formed and broken several times during a contraction, acting like tiny ratchets to generate tension and propel the thin filaments toward the centre of the sarcomere. As this event occurs simultaneously in sarcomeres throughout the cell, the muscle cell shortens. The I bands shorten, the distance between successive Z discs is reduced, the H zones disappear, and the contiguous A bands move closer together but do not change in length.

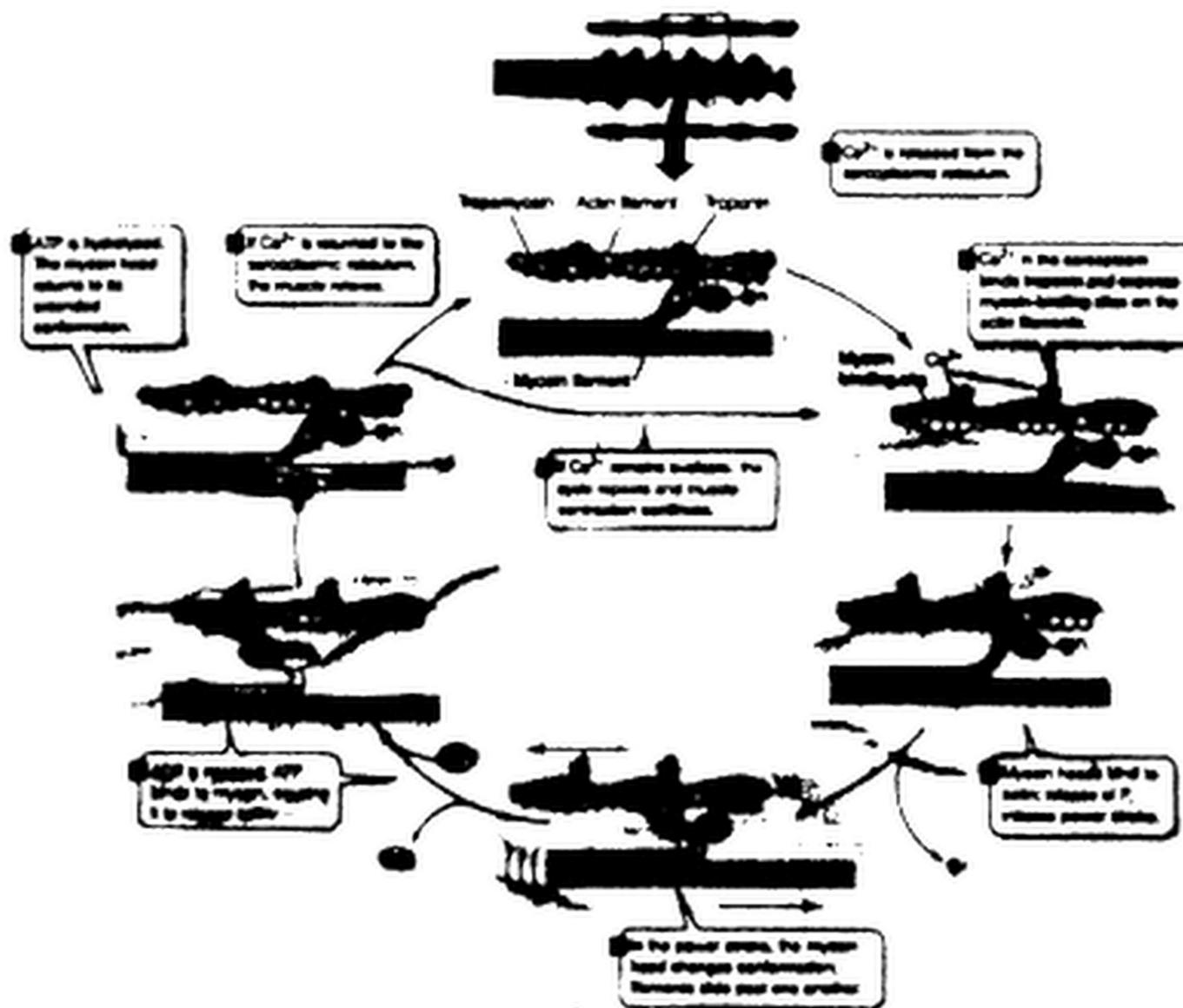


Fig. The sliding filament model

Control of Cross Bridges

Muscle contraction is initiated by nerve impulse arriving the neuromuscular junction. The nerve impulse is carried through the sarcolemma to the T tubule then to the sarcoplasmic reticulum (SR). The calcium gates of the SR open releasing calcium into the cytosol. When muscle is at rest the tropomyosin is disposed in such a way that it covers the sites on the actin chain where the heads of myosin become attach. When muscle is required to contract, calcium ions bind with the troponin molecules and cause them to move slightly. This has the effect of displacing the tropomyosin and exposing the binding sides for the myosin head. Once the myosin head has become attached to the actin filament, ATP is hydrolysis to ADP and phosphate (Pi) and the crossed bridges are broken down. The formation and breakdown of cross brides occur again and again during the sliding of the filament.

Q11. Describe the action of anatogonistic muscle in the movement of knee joint in man.

Answer

Antagonistic Arrangement of Skeletal Muscles

Bones are attached to the bones through connective tissue called ligament. When a muscle contracts one end normally remains stationary and the other end is drawn towards it. The end which remains stationary is called origin and that which moves is called insertion. Both are the points of attachment to bones. Every muscle has its own origin and insertion. Belly is the thick part between origin and insertion which contract. Normally the bones of insertion is pulled upon when muscle contracts and drawn towards origin, one bone moving on the other at the joints. Flexor muscle when contracts it bends the bone at joint. Extensor muscle when contracts it straightens the bone at joints. For the movement of the bone in two directions muscles work in pairs. When flexors contract the extensors relax and vice versa. Such arrangement of muscles is called antagonistic arrangement.

Movement in Knee Joint

Knee or tibio-femoral joint is located between the femur and tibia. It is a complex hinge joint that permits limited rolling and gliding movements in addition to flexion and extensions.

The flexion is carried out by the flexor muscles. These are hamstring muscles present at the back of the upper part of the leg (thigh). The major hamstring muscle is biceps femoris. It has two origins, one from pelvic girdle and other from the top of the femur. At its insertion the tendon divides into two portions to attach at the upper part of the tibia and fibula.

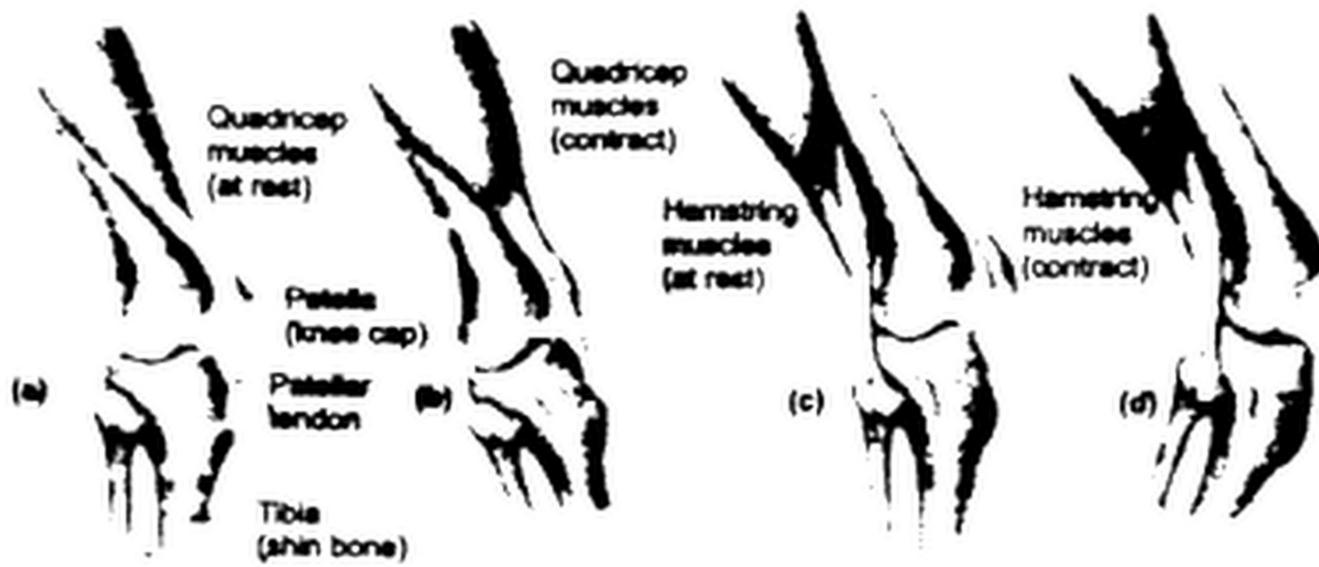


Fig. movement at knee joint

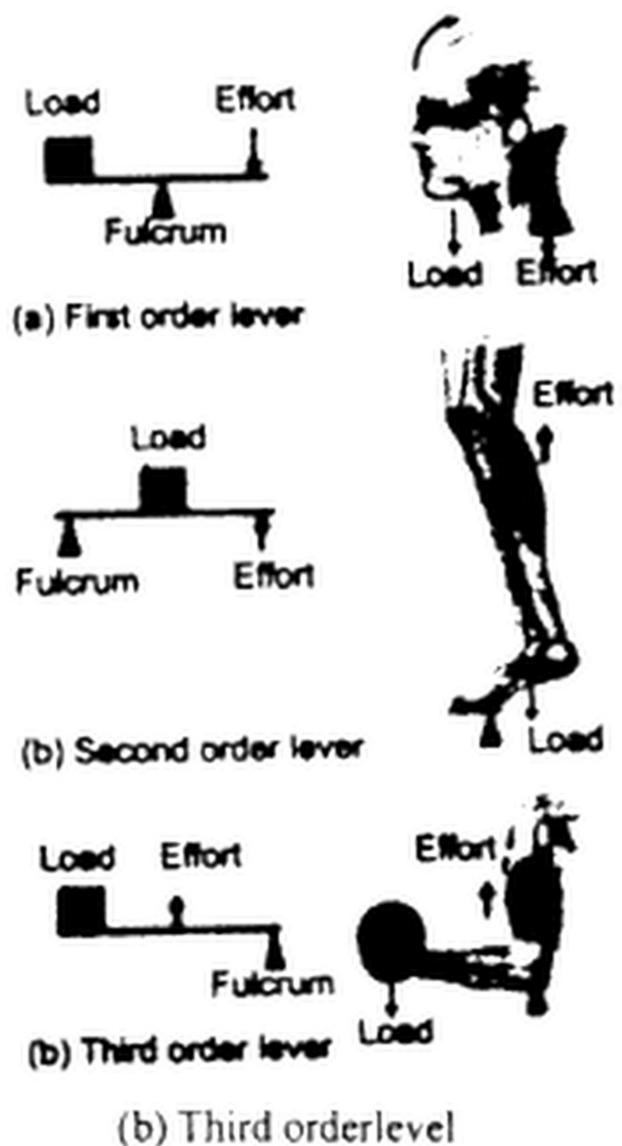
The extension is carried out by the extensor muscles which are present in the front of the thigh. The main extensor muscles are quadriceps femoris. They originate at the ilium and femur, come together in a tendon surrounding the patella (kneecap), and insert at the tibia. These extend the leg at the knee joint and are important for standing, walking, and almost all activities involving the legs.

Q12. Justify how the main functions of skeleton acts as a system of rods and levers, which are moved by muscles?

Answer

Skill Analyzing and Interpreting

A lever is any rigid structure that runs about a fulcrum when force is applied. Levers are generally associated with machines but can also apply to human body. In the body, synovial joints usually serve as the fulcra (sing: fulcrum) (F), the muscles can provide force or effort (E), and the bones acts as the rigid lever arms that move the resisting object. There are three kinds of levers, determined by the arrangement of their parts. In first order lever, the fulcrum is positioned between the effort and the resistance. In the human body the head at the atlanto-occipital joint, straightening of the elbow. In the second order lever, the resistance is positioned between the fulcrum and the effort. Contraction of the calf muscles (E) to elevate the body on the toes, with the ball of the foot acting as the fulcrum is an example in the human body. In the third order lever, the effort lies between the fulcrum and the resistance. The flexion of the elbow is an example.



Q13. Justify why do the muscles pull but do not push?**Answer**

Bones act as the levers, while joints perform as living fulcrums. Muscle, attached to bones by tendons and other connective tissue, exerts force by converting chemical energy into tension and contraction. When a muscle contracts, it shortens, in many cases pulling a bone like a lever across its hinge. Muscles move and by their motions we move. We are capable of performing a wide variety of actions, but despite this, muscle itself move only by becoming shorter. They shorten and then they rest – in other words, a muscle can pull but it cannot push.

Q14. Give explanations for following statements.

- a) Pregnant women should be encouraged to drink milk.
- b) The sutures of skull are fixed joints.
- c) The human femur is stronger than humerus.

Answer

- a) Osteoporosis, is common disease characterised by reduced bone mass and increased risk of fracture. Osteoporosis occurs because in the bone resorption exceeds bone deposition.

In pregnancy, to avoid osteoporosis it is advised to drink more & more milk so that the level of calcium would remain in proper quantity in bones.

- b) Fibrous joints firmly bind skeletal elements together with fibrous connective tissues. The three kinds of fibrous joints are sutures, syndesmoses and gomphoses. Sutures are characterised by a thin layer of dense irregular connective tissue that binds the articulating bones sutures are found only within skull.



Fig. Structure of skull

- c) Femur or thigh bone is a long bone with head, which fits into the acetabulum. Femur is more stronger than humerus bone because femur bone has to lift up the upper heavy portion of human, so femur having more proportion of calcium and phosphate as compared to the proportion of calcium and phosphate in humerus.

Q15. Name the techniques for joint replacement.**Answer**

Many joints of the body can be replaced by artificial joints. Joint replacement is called

silastic or elastomer. The bone of the articular area is removed on one side. This procedure called partial joint replacement or hemi-replacement technique. When both sides of the articular area are removed it is called total joint replacement technique. The artificial articular areas are glued to the bone with a synthetic adhesive, such as methyl methacrylate.

Q16. Relate the bipedal posture of man with his skeletal and musculature.

Answer

Curvatures of vertebral column help to balance the body for bipedal stance. The intervertebral discs lend flexibility to the vertebral column and absorb vertical shock. The structure of the pelvis, in its attachment to the vertebral column, permits upright posture and locomotion on two appendages (bipedal locomotion). Certain muscles are active posture muscles, whose primary function is to work in opposition to gravity. For example, the strong, complex muscles of the vertebral column are adapted to provide support and movement in resistance to the effect of gravity. Thus, the skeleton and muscular systems maintain the bipedal posture of man.

Q17. Justify the use of calcium in teenage and twenties can be a preventive action against osteoporosis.

Answer

Osteoporosis, is a common disease characterised by reduced bone mass and an increased risk of fracture. In normal individuals, bone mass increases during skeletal growth to reach a peak between the ages of 20 and 25 but falls thereafter in both sexes. Osteoporosis, occurs because in the bone resorption exceeds bone deposition. The increased calcium is used to increase bone mass. The greater the bones mass before the onset of osteoporosis, the greater the tolerance for bone loss later in life. For this reason, it is important for adults, especially women in their twenties and thirties, to ingest adequate amounts of calcium.

Q18. Justify why do muscle pull but do not push?

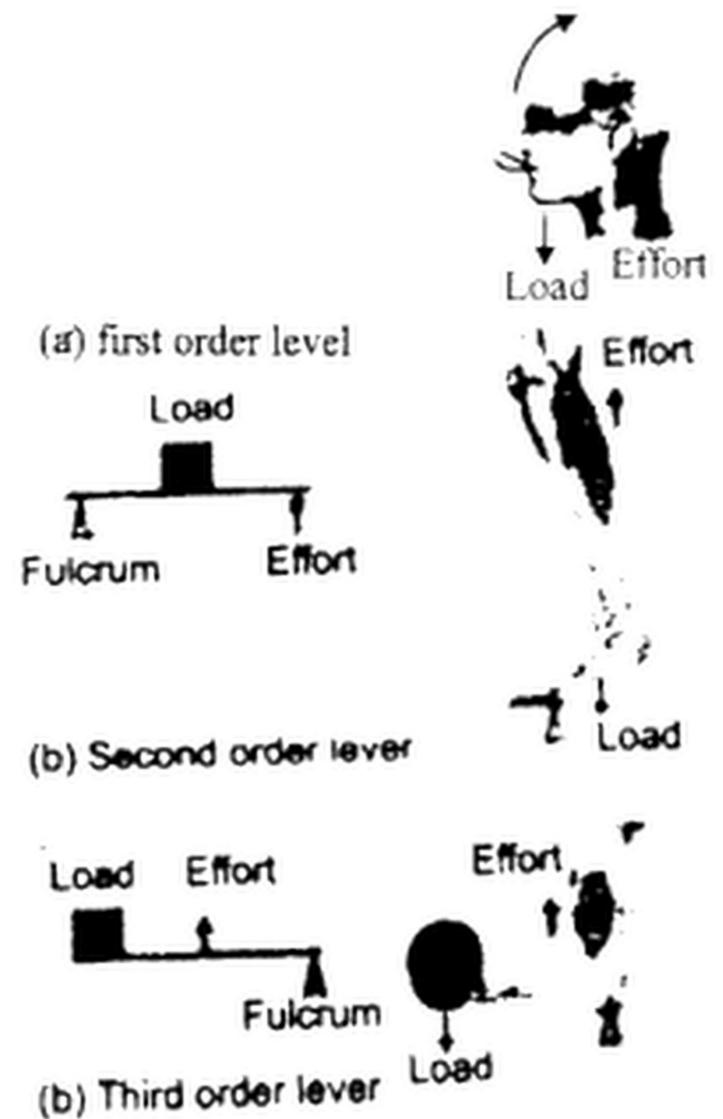
Answer

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Q19. Justify how the main functions of the skeleton are to act as a system of rods and levers, which are moved by the muscles?

Answer

A lever is any rigid structure that runs about a fulcrum when force is applied. Levers are generally associated with machines but can also apply to human body. In the body, synovial joints usually serve as the fulcra (F), the muscles can provide force of effort (E), and the bones acts as the rigid lever arms that move the resisting object. There are three kinds of levers, determined by the arrangement of their parts. In first order lever, the fulcrum is positioned between the effort and the resistance. In the human body the head at the atlanto-occipital joint, straightening of the elbow. In the second order lever, the resistance is positioned between the fulcrum and the effort. Contraction of the calf muscles (E) to elevate the body on the toes, with the ball of the foot acting as the fulcrum is an example in the human body. In the third order lever, the effort lies between the fulcrum and the resistance. The flexion of the elbow is an example.



Q20. Reason out the rigor mortis.

Answer

When death occurs, ATP is no longer made. It is a short-lived chemical and so it runs out fairly quickly. This causes the muscles to lock into position as cross-bridges that formed between actin and myosin filaments before death can no longer be broken. The skeletal muscles undergo a partial contraction the causes the joints to become fixed. This condition, rigor mortis (rigidity of death), happens in all body muscles. It appears about four hours after death and lasts about 34 hours. After this time muscles proteins are destroyed by enzymes within the cells and so rigor mortis disappears.

KEY POINTS

- The skeleton in animals contributes in upholding and sustaining the body against gravity and other external forces.
- The vertebrate skeleton is composed either of cartilage or bone.
- Cartilage consists of cells called chondrocytes and a tough, flexible matrix made of type II collagen and it is without blood vessels.
- Bone is a living hard and strong structure consisting of a hard ground substance or matrix and cells.

