



# EXPERIMENT

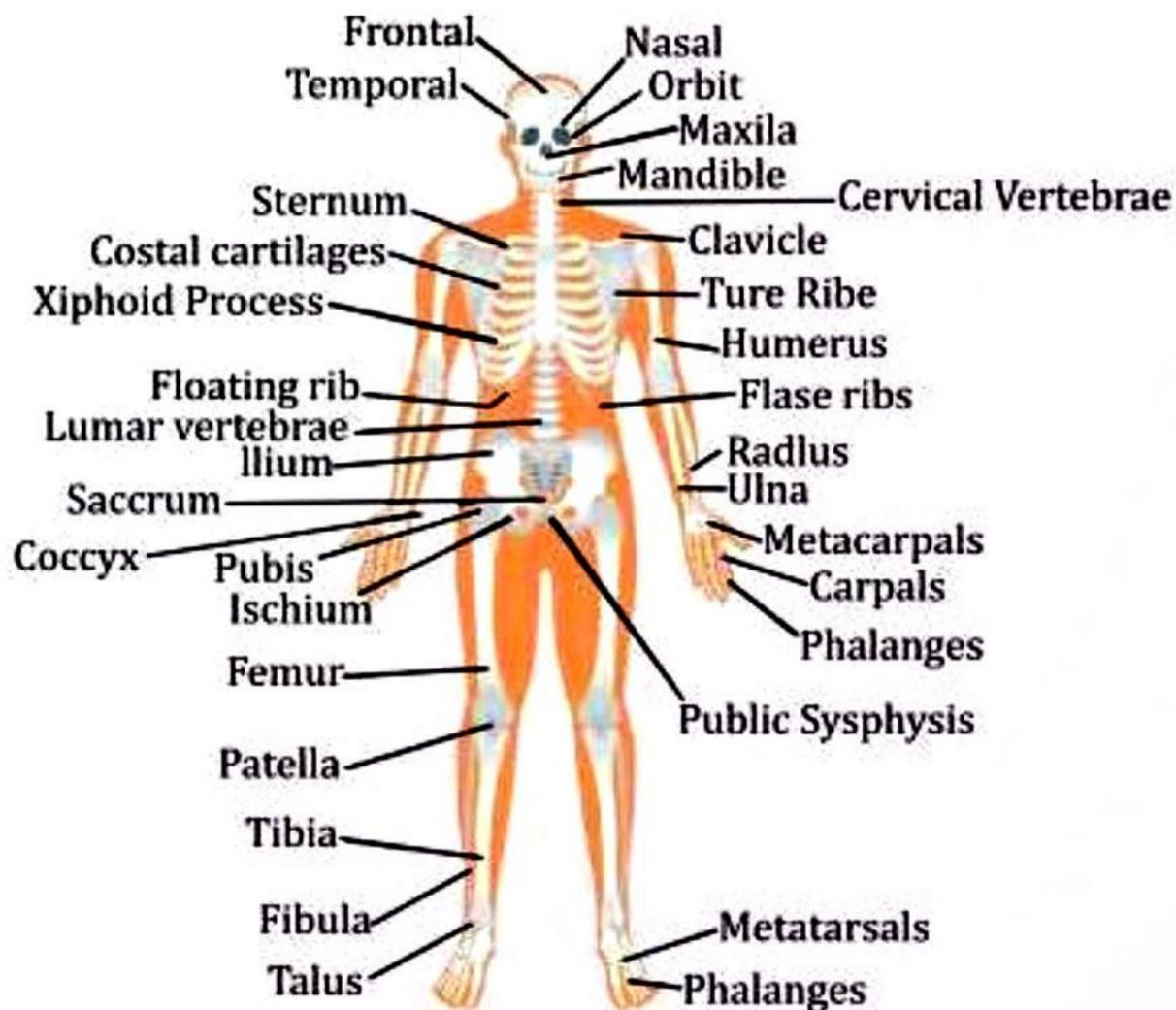
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## Aim

To study the human skeleton with the help of virtual images/models only.

## Theory

The hard supportive or protective elements of the animal body constitute the skeleton or skeletal system. The skeleton consists of a framework of bones and a few cartilages. Bone and cartilage both are specialized connective tissue.



The number of bones in appendicular skeleton can be summarised as follows.

<b>(i) Upper region</b>	<ul style="list-style-type: none"> <li>— Pectoral girdle</li> <li>— Arm and hands</li> </ul>	4	} 64
		60	
<b>(ii) Lower region</b>	<ul style="list-style-type: none"> <li>— Pelvic girdle</li> <li>— Legs and feet</li> </ul>	2	} 62
		60	
Total bones		206	

Skeleton system provides support to softer body parts and protects the delicate internal organs like brain, heart, lung, etc. Besides these major functions, skeleton also provides surface for muscle attachment, helps

movement, helps in manufacturing blood corpuscles in bone marrow, etc.

## **MATERIAL REQUIRED**

Chart or model of human skeleton, pencil, paper, practical record book, eraser, practical guide.

## **PROCEDURE**

1. Observe different types of bones present in human skeleton.
2. Draw a well labelled diagram of the bones and write the comments in your notebook.

## **OBSERVATIONS**

### **HUMAN SKELETON**

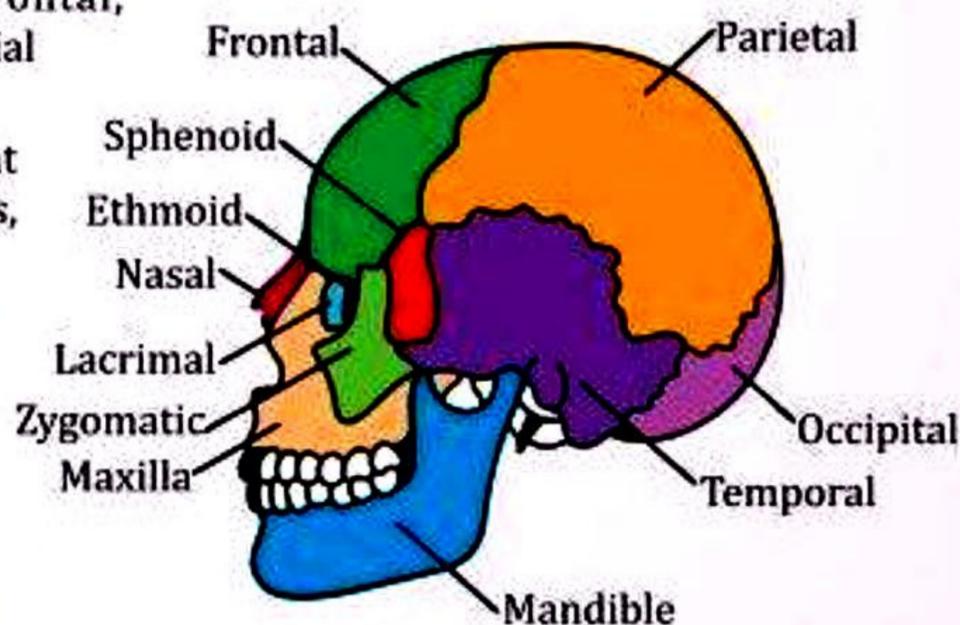
#### **Characteristics**

1. The given model is the endoskeleton of human
2. It is composed of 206 bones in an adult person.
3. It is differentiated into axial skeleton and appendicular skeleton It comprises of the following bones.

### **A. HUMAN SKULL**

#### **Characteristics**

1. It is the bony framework of head protecting the brain
2. It possesses a strong bone case for the brain which is called cranium and is made up of 8 bones
3. It is composed of two sets of bones, i.e. cranial and facial that form a total of 22 bones.
4. Cranial bones are occipital, parietal, frontal, temporal, sphenoid and ethmoid bones Facial bones form the front part of the skull.
5. Distinct sutures in zig-zag fashion are present at the junctions of the frontal with the parietals, as well as between two parietals.
6. Corresponding to their location in the body, the cranial bones have a strong bone case for eyes called an orbit.
7. The front or anterior part of the skull is composed of 14 bones. A nasal passage is formed by nasal bones present below the orbit.
8. Human skull is dicondylice, i.e. the skull region articulates with vertebral column with the help of two occipital condyles.
9. Maxilla and pre-maxilla bones form the upper jaw and the mandible bone forms the lower jaw. These two bones also form the face and into them are lodged teeth in special sockets. Teeth are not bones
10. A U-shaped bone present at the base of buccal cavity is the hyoid bone.
11. In the middle of the floor of cranium, a large opening is found which is called as foramen magnum, through which brain gets connected to the spinal cord.

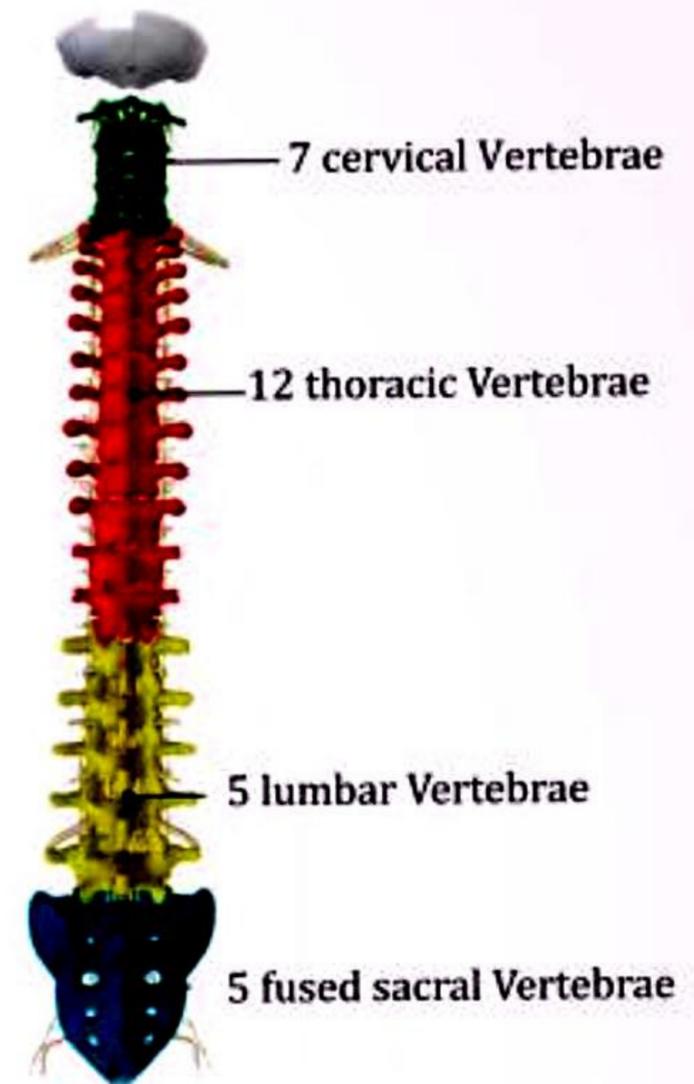


### **B. VERTEBRAL COLUMN**

#### **Characteristics**

1. It is also called as spine or backbone and is dorsally placed extending from the base of the skull and constitutes the main framework of trunk.
2. Vertebral column forms the central axis of the body and helps it to keep it erect.

3. It encloses the spinal cord and protects it.
4. It is made up of 26 serially arranged units called vertebrae (sing. Vertebra).
5. Each vertebra has a central hollow portion called neural canal through which the spinal cord passes.
6. The first vertebra is called atlas and it is the part of spinal cord which articulates with the occipital condyles of skull.
7. Vertebrae are of following five types. i.e. cervical, thoracic, lumbar, sacral and coccygeal or coccyx
8. It constitutes four curves that enhance balancing power and firmness for upright posture of the body.
9. Five sacral vertebrae are fused into one bone and four coccygeal vertebrae are also fused together to form one bone.
10. The vertebral formula for human is C7, T12, L5, S(5), C(4).
11. Vertebral column supports the head and serves as a point of attachment for the skull, ribs,
12. pectoral, and pelvic girdles. It also allows flexing and bending of the back and body.



### Structure of A Typical Vertebra

#### Characteristics

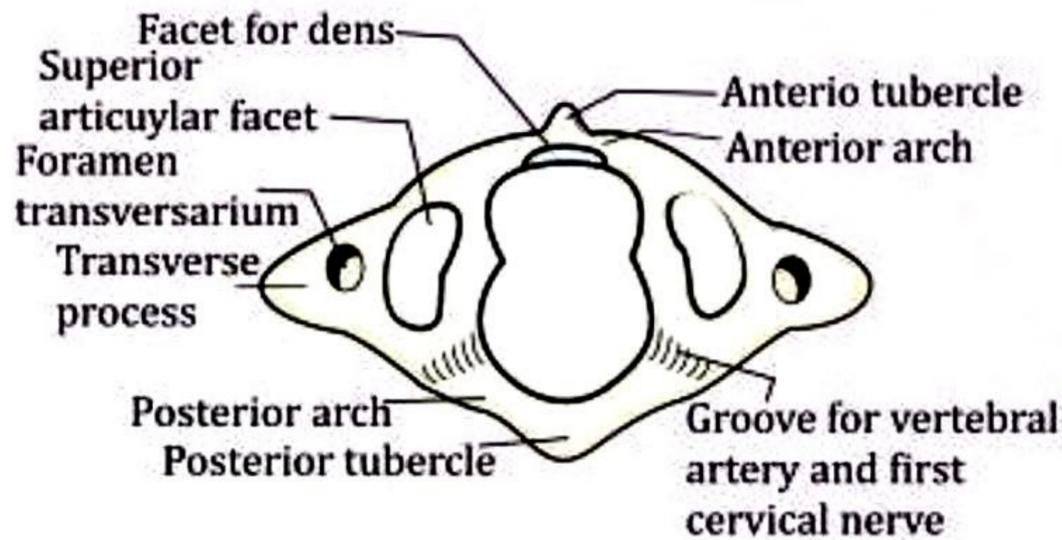
1. The basic structure of all the vertebrae is same with a ring-like structure.
2. Typical vertebra has a large, disc-like anterior, flattened portion called centrum or body.
3. Centrum is the base of a vertebra and forms articulation joints which are slightly movable.
4. It is flat in mammals which is called amphiplatyon.
5. There is a hole in the typical vertebra called vertebral or neural canal It provides passage for spinal cord.
6. There is a pointed structure on the dorsal surface called neural spine or spinous process which provides protection to the spinal cord.
7. The side of neural canal of vertebra is called neural arch and possesses six different processes, Le two superior articular processes (pre-zygapophysis), two inferior articular processes (post-zygapophysis) and two transverse processes.
8. Intervertebral discs are present between the centre of two neighboring vertebrae.

#### (a) Atlas Vertebrae or First Cervical Vertebra

##### Characteristics

1. It is the first cervical vertebra and it articulates with the occipital condyles.
2. The number of cervical vertebrae is seven in almost all the mammals.
3. Atlas lies just below the skull and has reduced centrum.
4. The transverse processes are long and broad while; spinous process is absent.

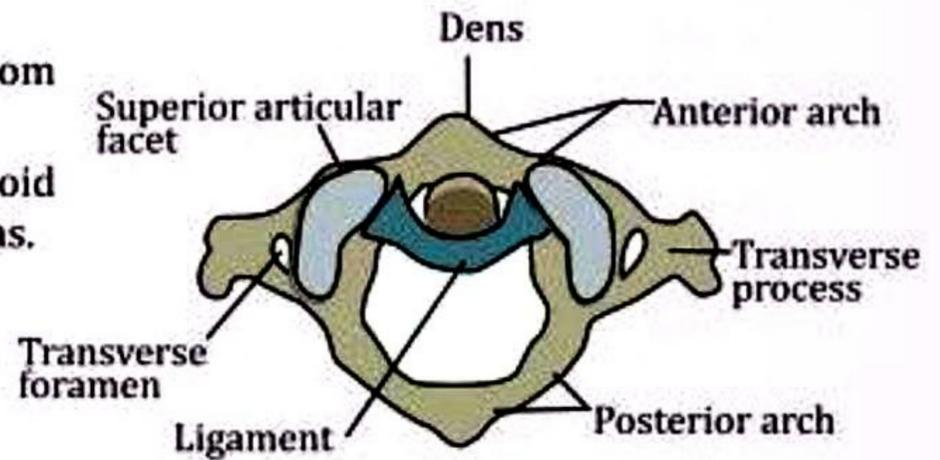
5. It helps in supporting the skull.



**(b) Axis Vertebra or Second Cervical Vertebra**

**Characteristics**

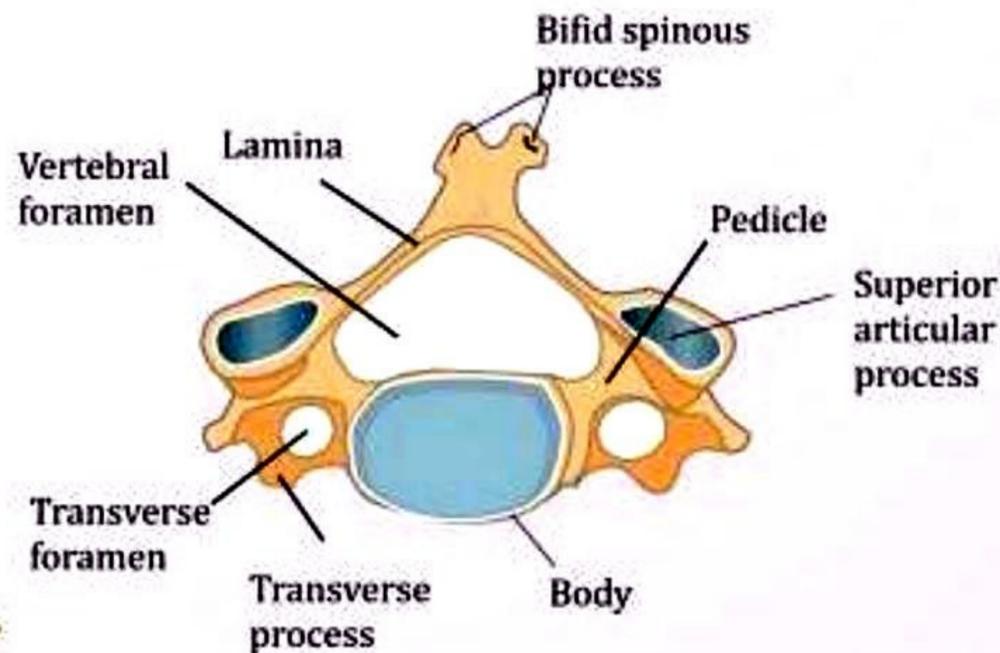
1. It is the second cervical vertebra that has a coelom centrum and lies below atlas vertebra.
2. It has an extension from centrum called odontoid process which acts as pivot for the rotation of atlas.
3. Odontoid process forms a hinge joint with atlas vertebrae and prevent the head from falling back.
4. It has small transverse processes and spinous process is raised and ridge-like.



**(c) Typical Cervical Vertebrae.**

**Characteristics**

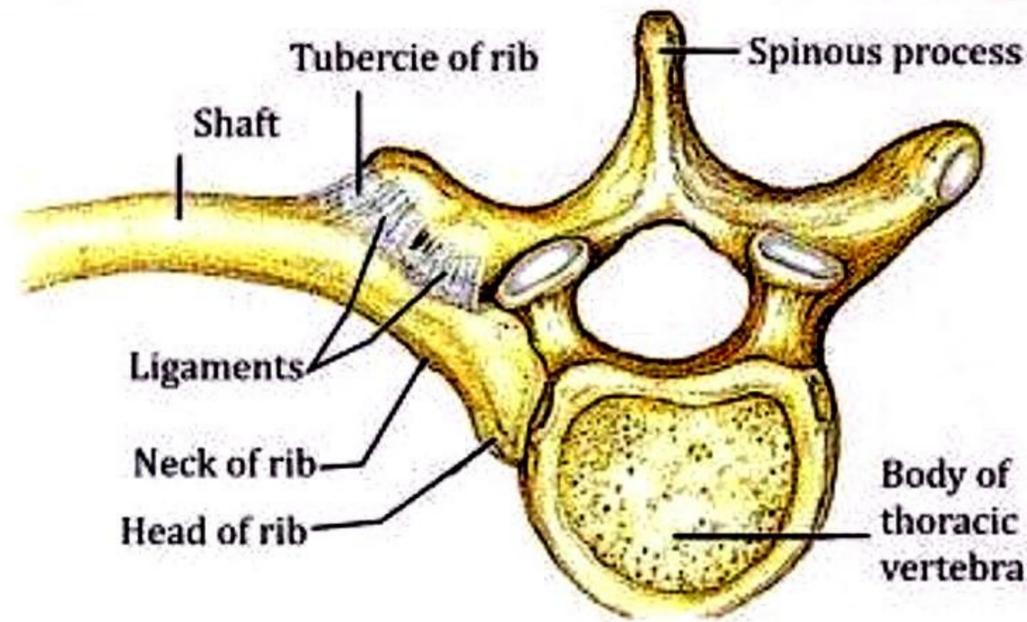
1. The third, fourth, fifth, sixth and seventh cervical vertebrae are called typical cervical vertebrae.
2. They have long bifurcated spines, cervical ribs and long transverse processes.



**(d) Thoracic Vertebrae**

**Characteristics**

1. These are found in chest region of vertebral column and are twelve in number.
2. The centrum of thoracic vertebrae is acoelus and is flat on the upper as well as lower side, i.e. amphiplatyon.

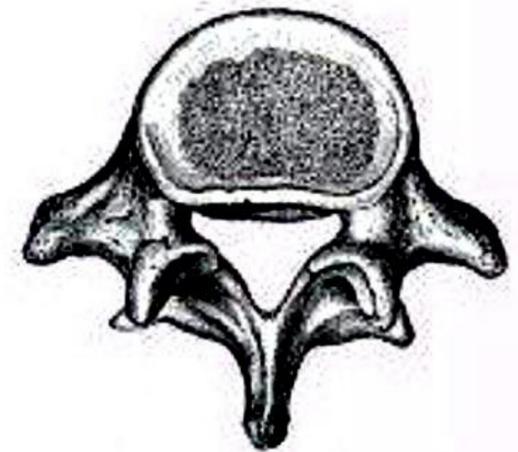


3. Centrum articulates with ribs having a demifacet (superior and inferior demifacets).
4. Transverse process is club-shaped or short and neural spine is well developed.

**(e) Lumbar Vertebrae**

**Characteristics**

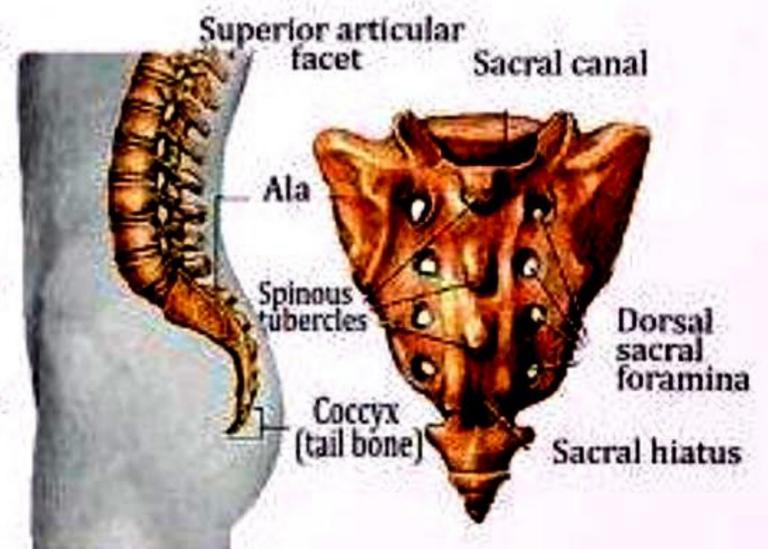
1. It is the largest and strongest in the vertebral column.
2. These are five in number and are found in abdomen region of vertebral column.
3. Centrum is big, flat and acoelus with well-defined neural spine.
4. Transverse process is thin, long, strong and well-developed with a small accessory process near its roof.
5. Lumbar vertebra supports the muscles of abdomen.



**(f) Sacral Vertebrae or Sacrum**

**Characteristics**

1. These are five in number and are present in thigh region of vertebral column
2. These are fused to form a single triangular bone called synsacrum
3. Sacrum have extra-articular surface and articulates with ilium of pelvic girdle
4. The transverse process of sacrum is modified into broad sloping mass that projects laterally from the body.



**(g) Caudal Vertebrae or Coccyx**

**Characteristics**

1. These are four in number that are fused to form coccyx.
2. These are found at the end of backbone and are vestigial in adult.
3. Transverse processes of coccyx are rudimentary.
4. Two coccygeal cornua are present that articulate with sacral cornua.

**Functions of the Vertebral Column**

1. Protects the spinal cord.
2. Carries body weight.
3. Cervical vertebrae allow free movement of the head.

4. Intervertebral disc provides flexibility to the body.

### C. THORACIC CAGE OR CHEST CAGE

#### Characteristics

1. It is made up of thoracic vertebrae, sternum and ribs.
2. It is also called as chest basket that covers and protects the vital organs like lungs and heart

#### (a) Sternum

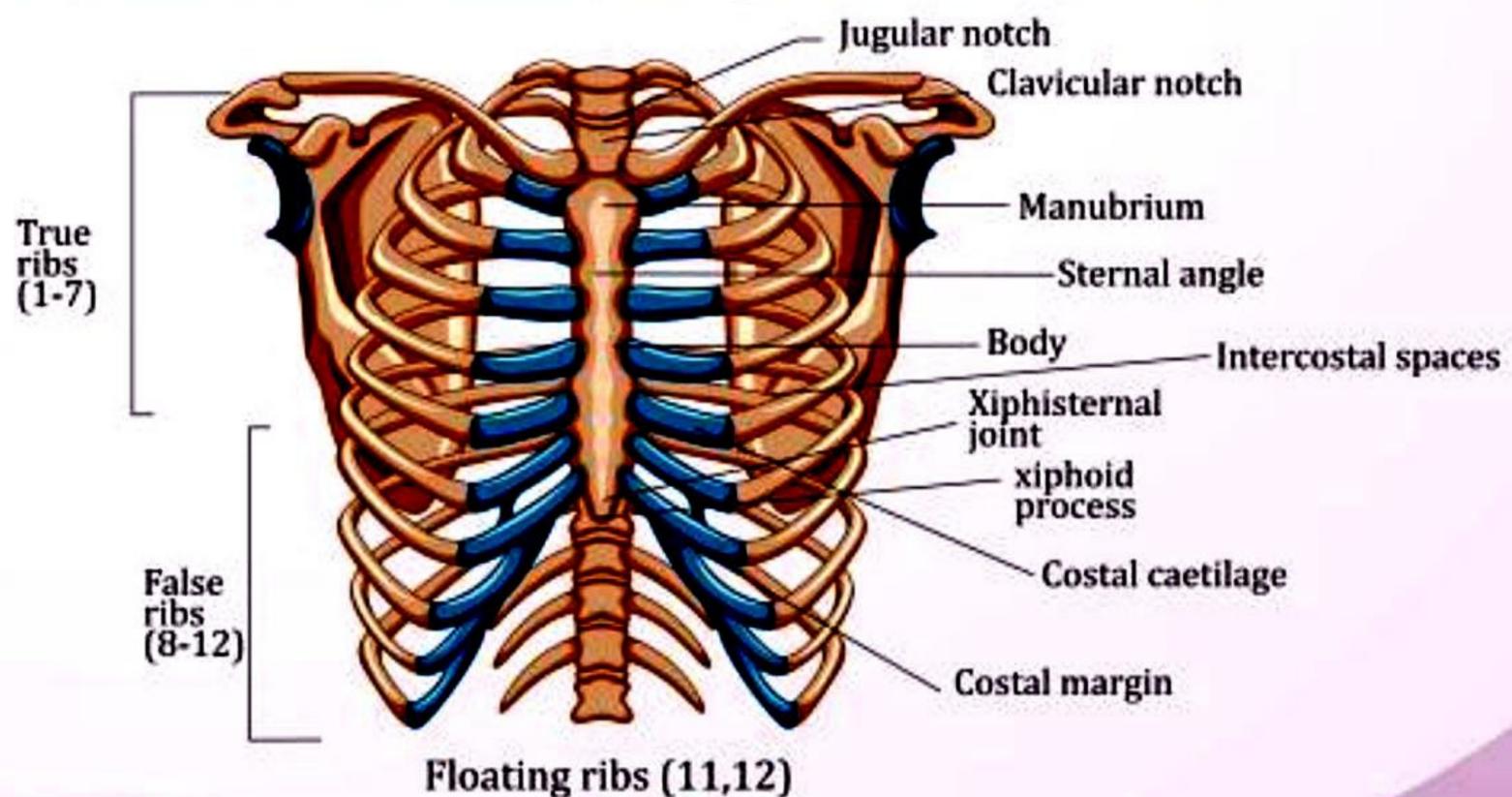
##### Characteristics

1. It is also called breast bone
2. It is a flat, dagger-shaped bone that lies just under the skin
3. The bone is located on the ventral midline of thorax in the middle in front of the chest)
4. It consist of three major parts:
  - (a) Hexagonal disc present at the top (manubrium)
  - (b) Middle portion (body).
  - (c) Lower end with reduced bone (xiphoid process)
5. It bears never notches for the articulation with ribs
6. Sternum provides surface for muscle attachment and helps in respiratory mechanism

#### (b) Ribs

##### Characteristics

1. These are thin, flat curved bones that form a protective cage around the vital organs of our upper body.
2. The ribs are composed of 24 bones arranged in 12 pairs.
3. It has two articulation surfaces on its dorsal end and hence, called as bicephalic. It has a head articulating with the Centrum, and Tubercle articulating with the transverse processes of vertebrae.
4. Out of the twelve pairs of rib the upper seven pairs are called true ribs as they are connected dorsally to the thoracic vertebrae and ventrally to sternum by hyaline cartilage.
5. The remaining five pairs of ribs are called false ribs as they do not articulate directly with sternal ribs. The 8th 9th and 10th pairs of ribs are attached to the 7th pair and indirectly to the sternum.
6. Ribs are protective in nature and help in respiration. Thoracic vertebrae, ribs and sternum



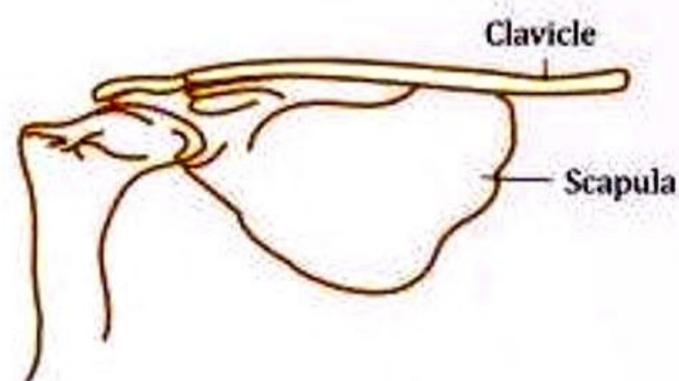
together constitute the rib cage.

- 11th and 12th pair of ribs (the last two pairs) are free as their anterior ends are not attached either to sternum or to another rib hence, they are called as floating ribs.

### (c) Pectoral Girdle

#### Characteristics

1. It is also called as shoulder girdle.
2. It consists of two bones:
  - (a) Scapula or shoulder blade.
  - (b) Clavicle or collar bone.



#### (a) Scapula of Pectoral Girdle

##### Characteristics

1. It is a large, flat and triangular bone that consists of a slightly elevated ridge called spine.
2. The end of each spine projects as a flattened and expanded portion called acromion process, it articulates with the clavicle.
3. Another process called coracoid process projects upwards from the broad end of scapula near acromion process.
4. Scapula below acromion process forms a socket-like cavity or depression (cup-like) called as glenoid cavity.
5. This cavity articulates with head of humerus bone forming shoulder joint.

#### (b) Clavicle of Pectoral girdle

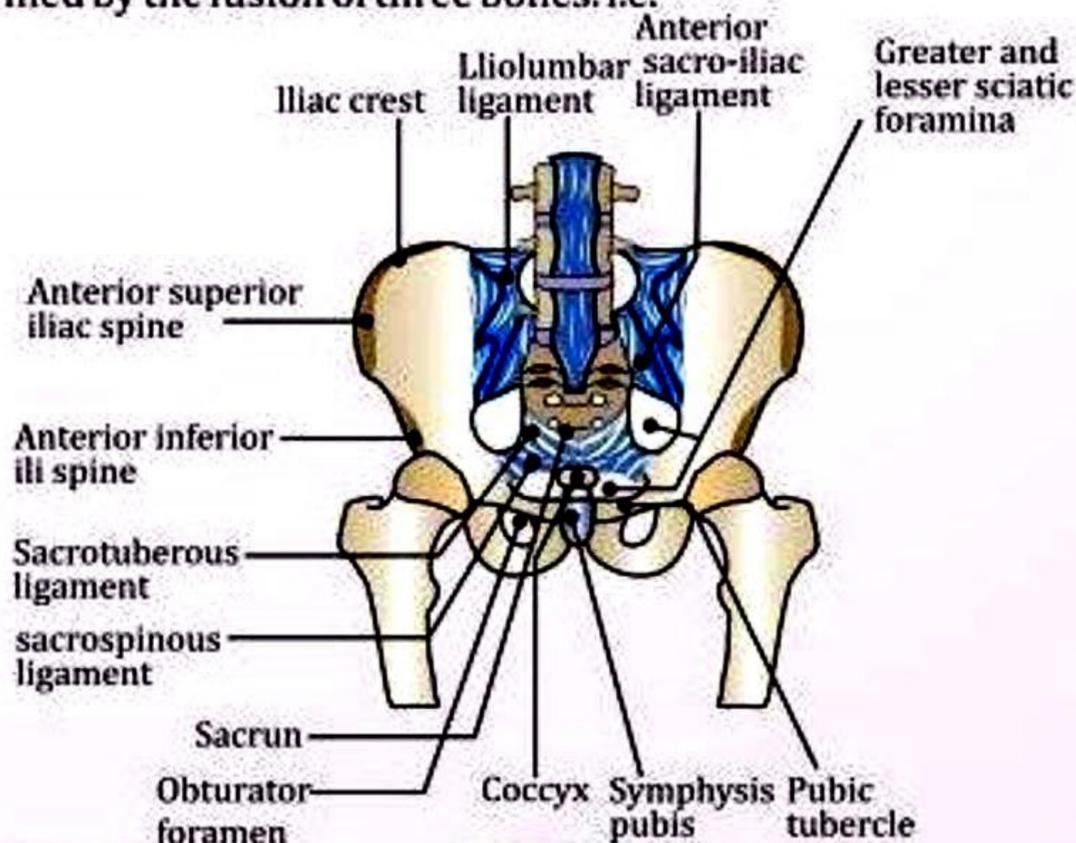
##### Characteristics

1. It is a long, slender bone with two curvatures, one at each end.
2. It articulates with the acromion.

### D. PELVIC GIRDLE OR HIP GIRDLE

#### Characteristics

1. It is located in the lower part of the trunk.
2. It consists of two coxal or hip bones also known as the two halves of the pelvic girdle. Each coxal is known as ossa coxal or innominate bone
3. Pelvic girdle is formed by the fusion of three bones. i.e.



- (i) Upper ilium
- (ii) Lower ischium
- (iii) inner pubis

4. All the three bones fuse to form a cup or socket-like depression called acetabulum which articulates with the head of femur to form the hip-joint.
5. Obturator foramen is the oval-shaped gap between ischium and pubis
6. Two halves of pelvic girdle meet ventrally to form pubic symphysis that contains fibrous cartilage
7. The ilium articulates anteriorly with the flat transverse process of sacral vertebrae.
8. It provides articulation to the bones of leg, supports and protects abdominal viscera and provides attachment to leg muscles.

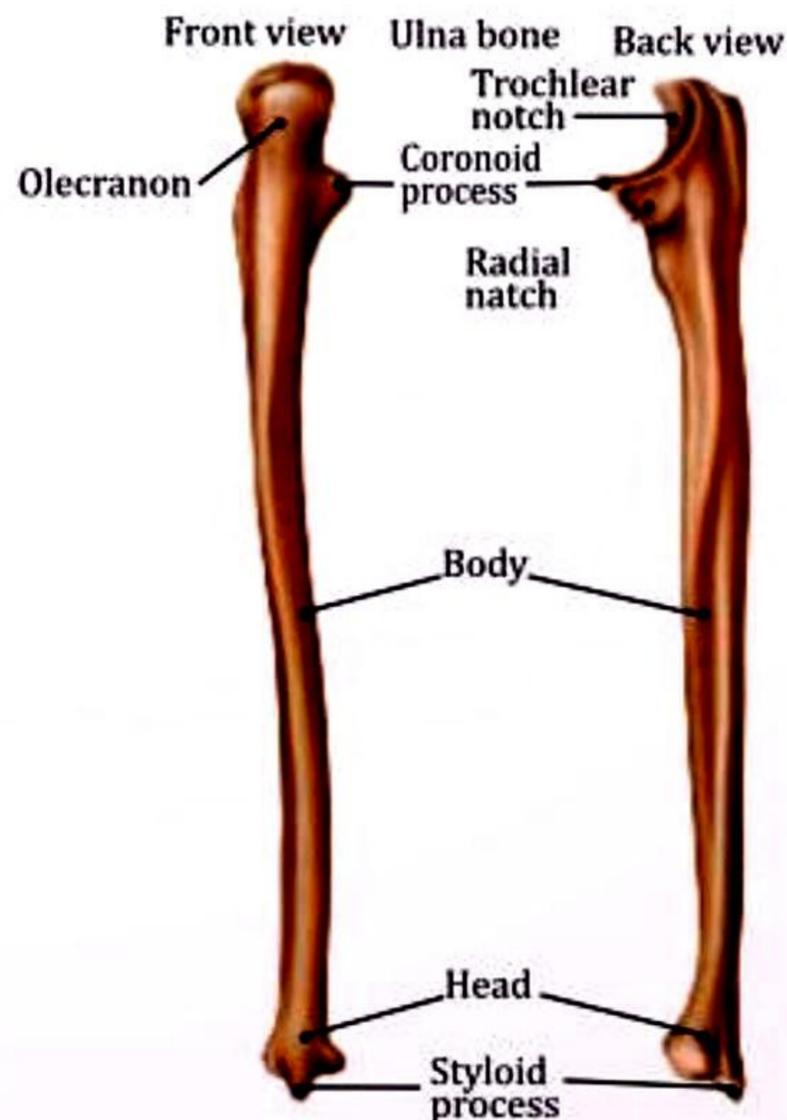
## E. BONES OF HAND OR FORELIMB

It is made up of bones consisting of humerus, radius and ulna, carpals, metacarpals and phalange

### (a) Humerus

#### Characteristics

1. It is the straight bone with a long shaft and forms the upper arm.
2. The rounded upper end of the head of the humerus fits into the glenoid cavity of the pectoral girdle.
3. It has a crest at its proximal end in the form of deltoid ridge for the attachment of arm muscles.
4. The distal end has a foramen and a trochlear process, which forms an elbow joint with radius and ulna.
5. Lower end is flattened with two projections called lateral and medial epicondyles.
6. A rounded knob-like structure is present below lateral condyle called capitulum.



## (b) Radius - Ulna

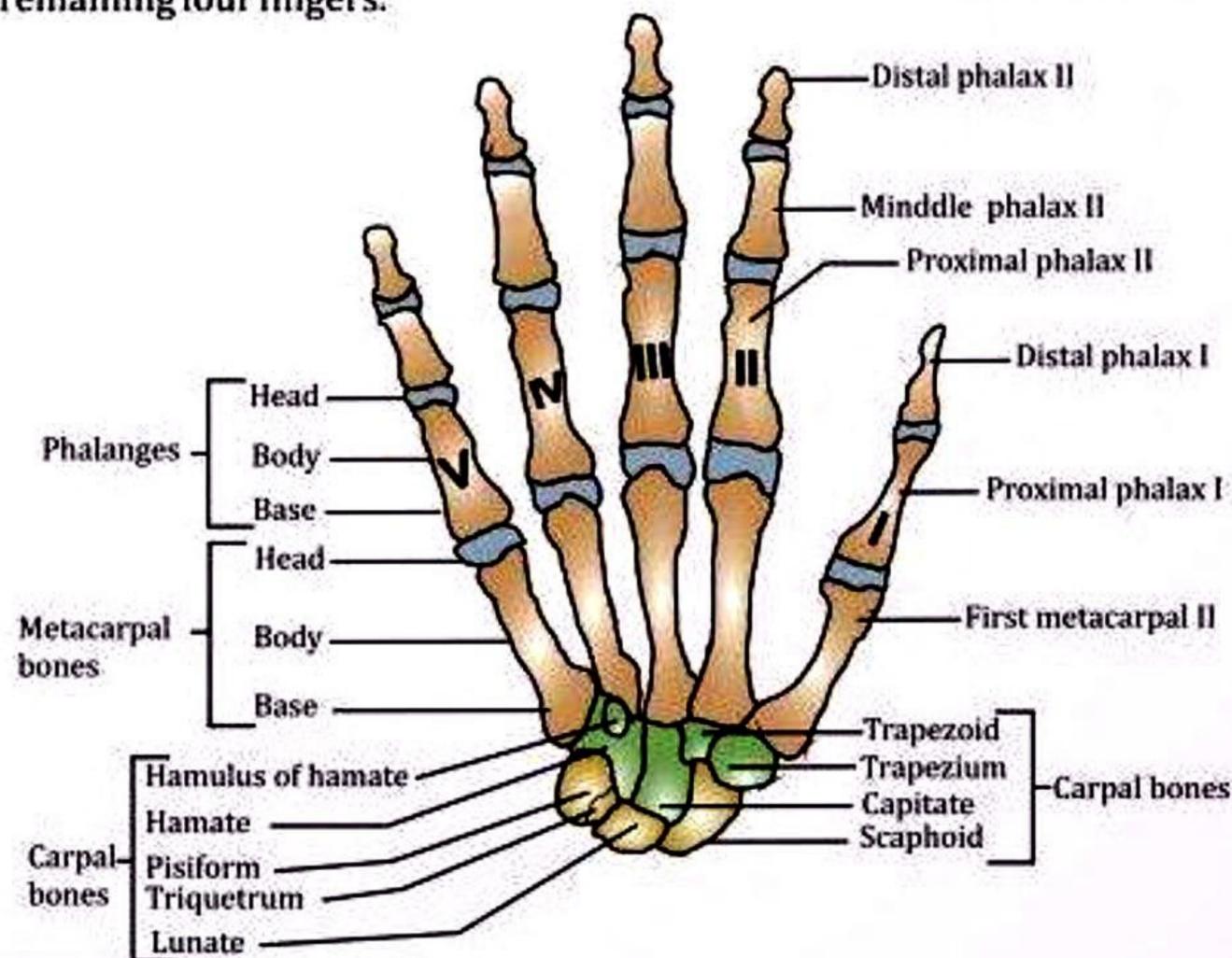
### Characteristics

1. Radius-ulna consists of two separate bones of the forearm, i.e. radius and ulna.
2. Ulna is medial, long (longer than radius) and well developed
3. It has larger olecranon process at upper end and a smaller coronoid process with semilunar trochlear notch in between. This articulates with trochlea of humerus.
4. Another notch called as radial notch is found on lateral side which articulates with radius
5. Radius is lateral and shorter than una and is head articulates with capitulum of humerus
6. These are two articular surfaces at the lower end of radius one for ulna and the other for wrist bones
7. Radius contributes to the movement of the wrist.

## (c) Carpals, Metacarpals and Phalanges

### Characteristics

1. Wrist or carpals are composed of 8 small bones These are scaphoid, lunate, triquetrum and pisiform (arranged in proximal row and trapezium, trapezoid, capitate and hamate (arranged in distal row)
2. Five long metacarpals form the palm of hand
3. 14 phalanges constitute the bones of fingers. There are two phalanges in thumb and three in each of the remaining four fingers.



## F. BONES OF LEG OR HINDLIMB

**Bones of leg or hindlimb constitute:** Femur, tibia and fibula, patella (knee cap) tarsals, metatarsals and phalanges.

### (a) Femur

#### Characteristics

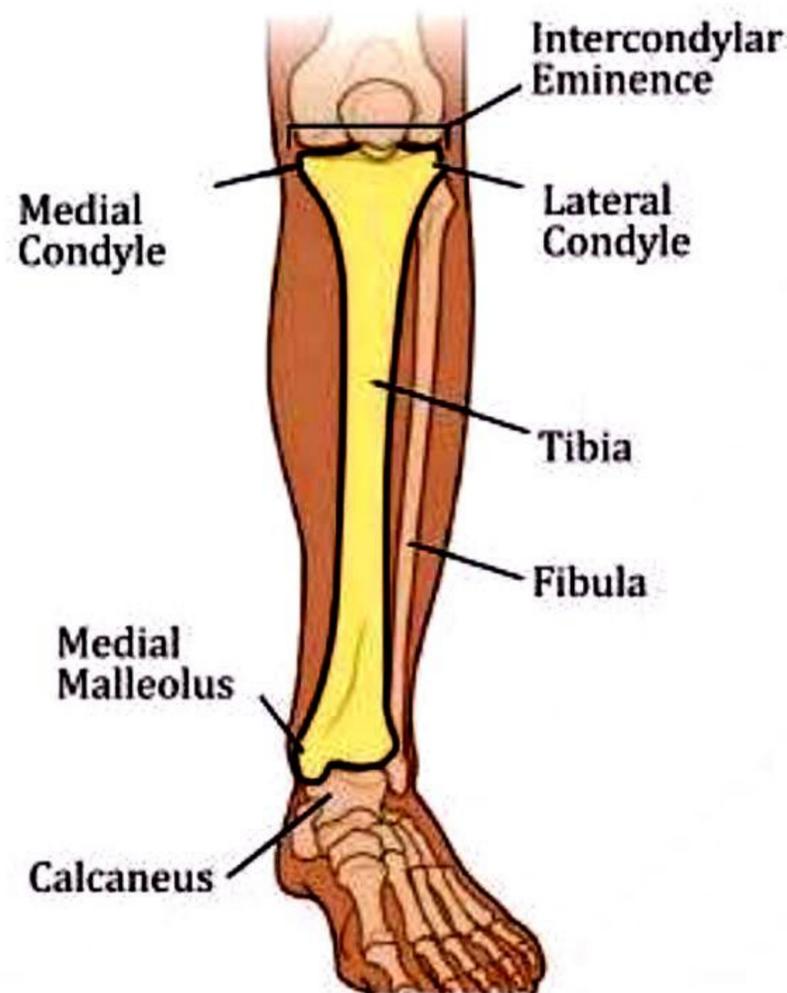
1. It is the longest bone of human skeleton system
2. The upper end has a rounded head that fits into the acetabulum of pelvic girdle

3. The proximal end has trochanters for attachment of thigh muscles
4. The distal end has two condyles that articulate with triangular-shaped patella and proximal part of tibia to form knee on the ventral side.

### (b) Tibia-Fibula

#### Characteristics

1. Tibia-fibula consists of two separate bones, i.e. tibia and fibula and are known as bone of the shank as they are present in the shank region of leg.
2. Tibia is a thick, long bone that lies medially and in front.
3. The upper end of tibia concave and articulates with femur and knee cap, while the lower end articulates with talus bone of ankle. It has a strong and medial process called medial malleolus.
4. Tibia more developed than fibula.
5. Fibula is short, thin and located more laterally and deeply.
6. The head or upper end of fibula articulates with upper end of tibia, while its lower end articulates with the end of tibia as well as with the talus by means of a lateral malleolus.



### (c) Patella

#### Characteristics

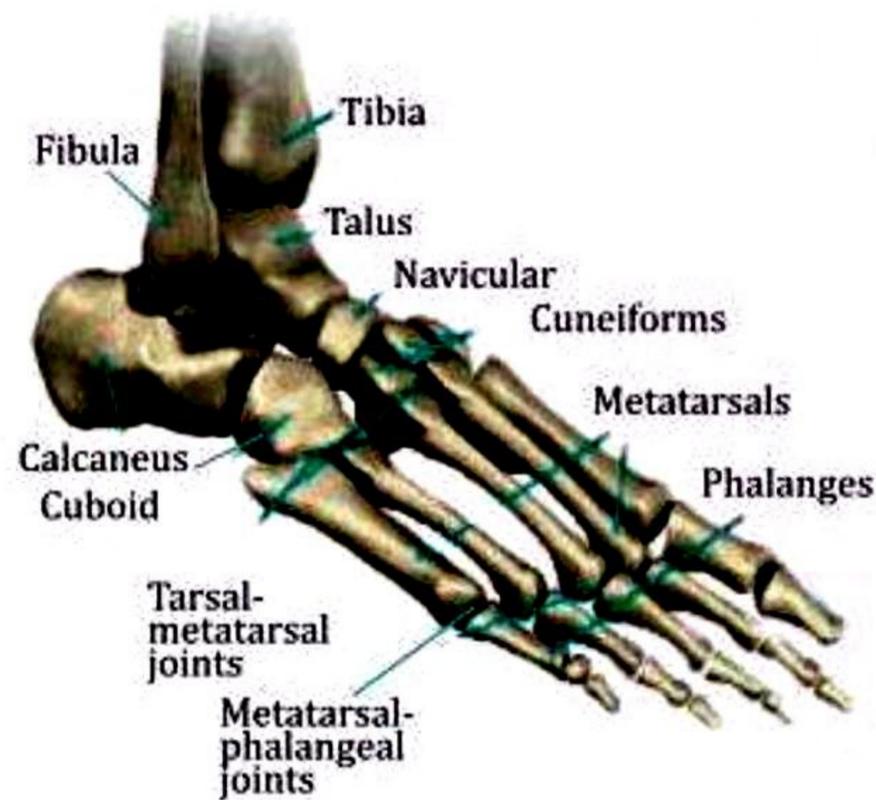
1. Patella's cup-shaped bone that covers knee ventrally.
2. It is a sesamoid bone i.e. bone embedded within a tendon.
3. These are formed by ossification in tendon of quadriceps muscles.

### (d) Tarsals, Metatarsals and Phalanges

#### Characteristics

1. These three types of bones constitute the bones of ankle and foot.
2. There are 7 tarsal bones which are arranged in two rows to form the ankle.
3. Calcaneum the largest and strongest bone which is calcareous and forms heel.

4. Metatarsals are composed of five bones that form foot. These are also called sole bones.
5. The bones of toes are called phalanges it consists of two bones in big toe and three bones in each of the remaining toes. Total number of changes are 14.



## PRECAUTIONS

1. The structure of bones should be observed carefully.
2. Femur humerus, radius-ulna and tibia-fibula should not be confused with each other i.e., important features of identification should be carefully observed and then identified.

## VIVA VOCE

**Q1. Which is the longest bone of human skeleton?**

**Ans.** Femur or thigh bones are the longest bone of human skeleton.

**Q2. In which bones the bone marrow is present?**

**Ans.** Long bone have bone marrow which is capable of manufacturing red blood corpuscles.

**Q3. Where does the head of femur articulate?**

**Ans.** The head of femur articulates in the cavity of the girdle called acetabulum.

**Q4. Name the smallest bone of human skeleton. Where is it found and also give the sequence of bones?**

**Ans.** Stapes is the shortest bone of human skeleton which is found in ear. The sequence of the three bones found in ear is malleus and stapes

**Q5. Study of skeleton system is termed as.**

**Ans.** Study of skeleton system is termed as osteology.

**Q6. What is the other name of bone stapes?**

**Ans.** Stirrup the other name of stapes.

**Q7. Name the first and second cervical vertebrae.**

**Ans.** Atlas is the first vertebra while axis vertebra is the second cervical vertebrae.

**Q8. Which region of vertebrae is the largest and strongest in vertebral column?**

**Ans.** Lumbar vertebrae is the largest and strongest region in the vertebral column.

**Q9. Sternum is divided into three parts. Name those three major parts of sternum.**

**Ans.** The three major parts of sternum are.

(i) Hexagonal disk present at the top called manubrium.

(ii) Middle portion called body.

(iii) Lower end with reduced bone, called xiphoid process.

**Q10. In how many different parts is thoracic cage or chest cage divided? Name them**

**Ans.** Thoracic cage or chest cage is made up of thoracic vertebrae sternum and ribs.



# EXPERIMENT

b

## Aim

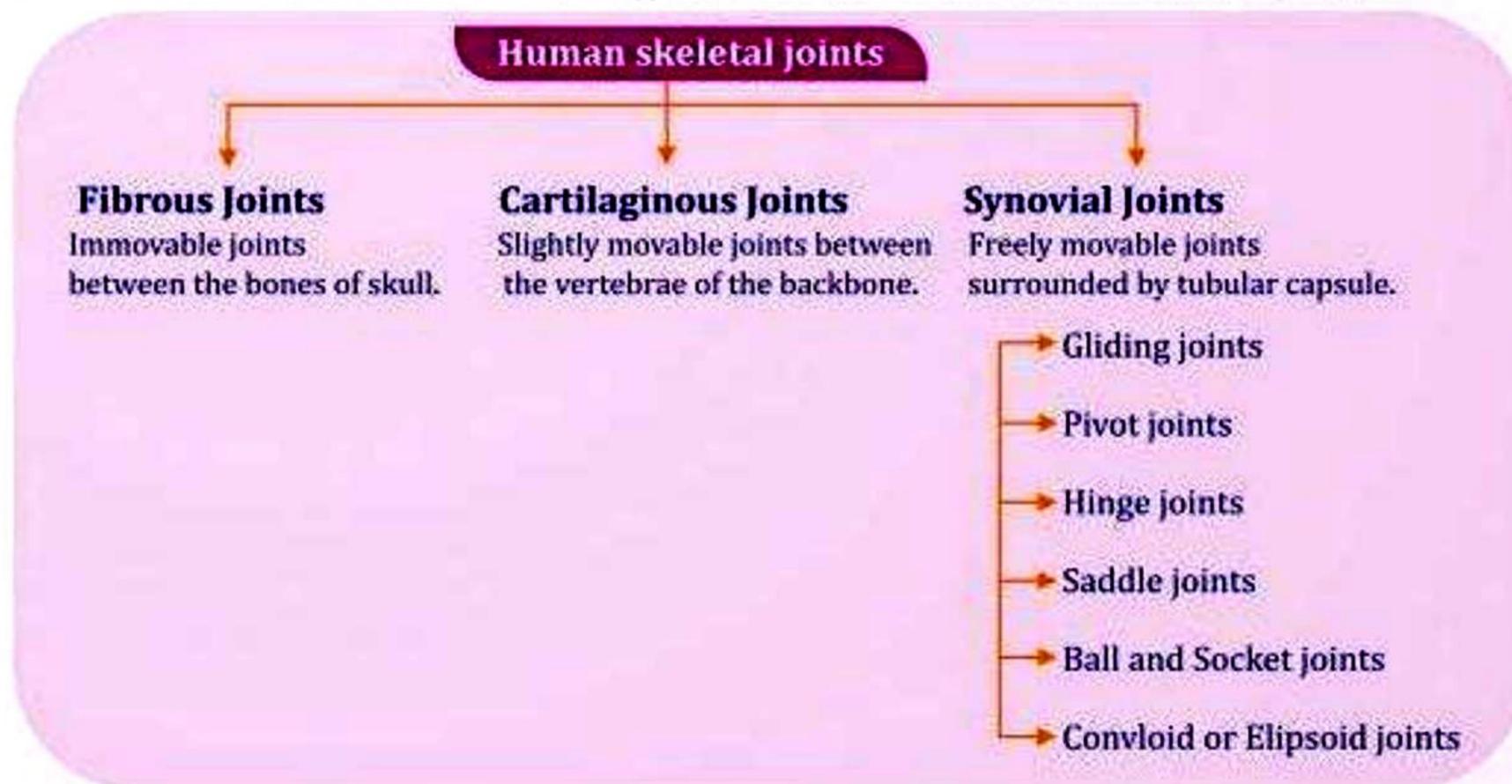
To Study of different types of human skeletal joints with the help of virtual image/models only.

## Theory

The regions of articulation between two or more bones or between a bone and a cartilage are called joints which are essential for all types of movements. These make the body flexible and also allow the growth of the structures that they connect to. Force generated by muscles is used to carry out movement through joints, which acts, as a fulcrum.

### Types of joints

Bones may be movable, slightly movable or immovable depending upon the nature of joints.



## Material Required

Specimen of human skeleton, charts and models of skeleton, pencil, eraser, practical record book, laboratory guide.

## Procedure

1. Observe the different types of bones and joints present in a human skeleton.
2. Draw the well labelled diagrams of the joints and write the comments in your practical record book.

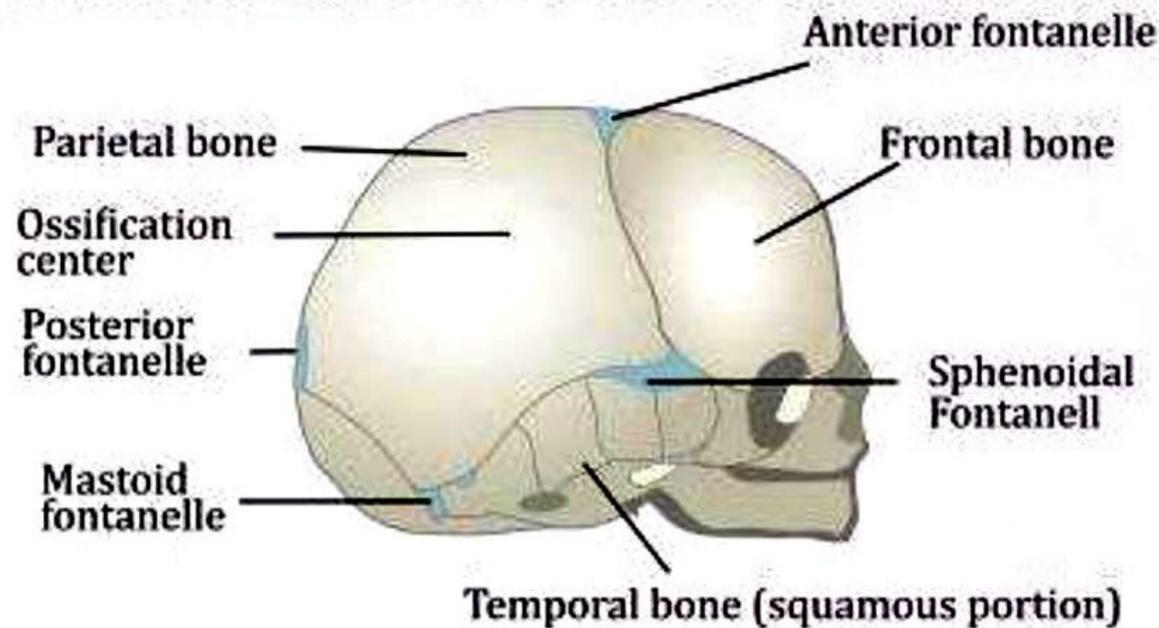
## Observations

### A. FIBROUS JOINTS

#### Characteristics

1. These are immovable joints which do not allow the movement of bones.

2. Bones are held firmly by bundles of white fibrous collagen.
3. The place of immovable joints are often called as sutures.
4. Syndesmosis or joint between tibia and fibula also shows fibrous joints besides skull joints.



## B. CARTILAGINOUS JOINTS

### Characteristics

1. These are slightly movable joints, also called as symphysis.
2. Fibro-cartilage or white fibrous cartilage is present between the ends of the bones taking part in the joint formation.
3. The bones are joined together by ligaments extending across the joints.
4. Pubic symphysis between the pubic bones of pelvic girdles also show cartilaginous joints besides joints of vertebral column.



## C. SYNOVIAL JOINTS

### Characteristics

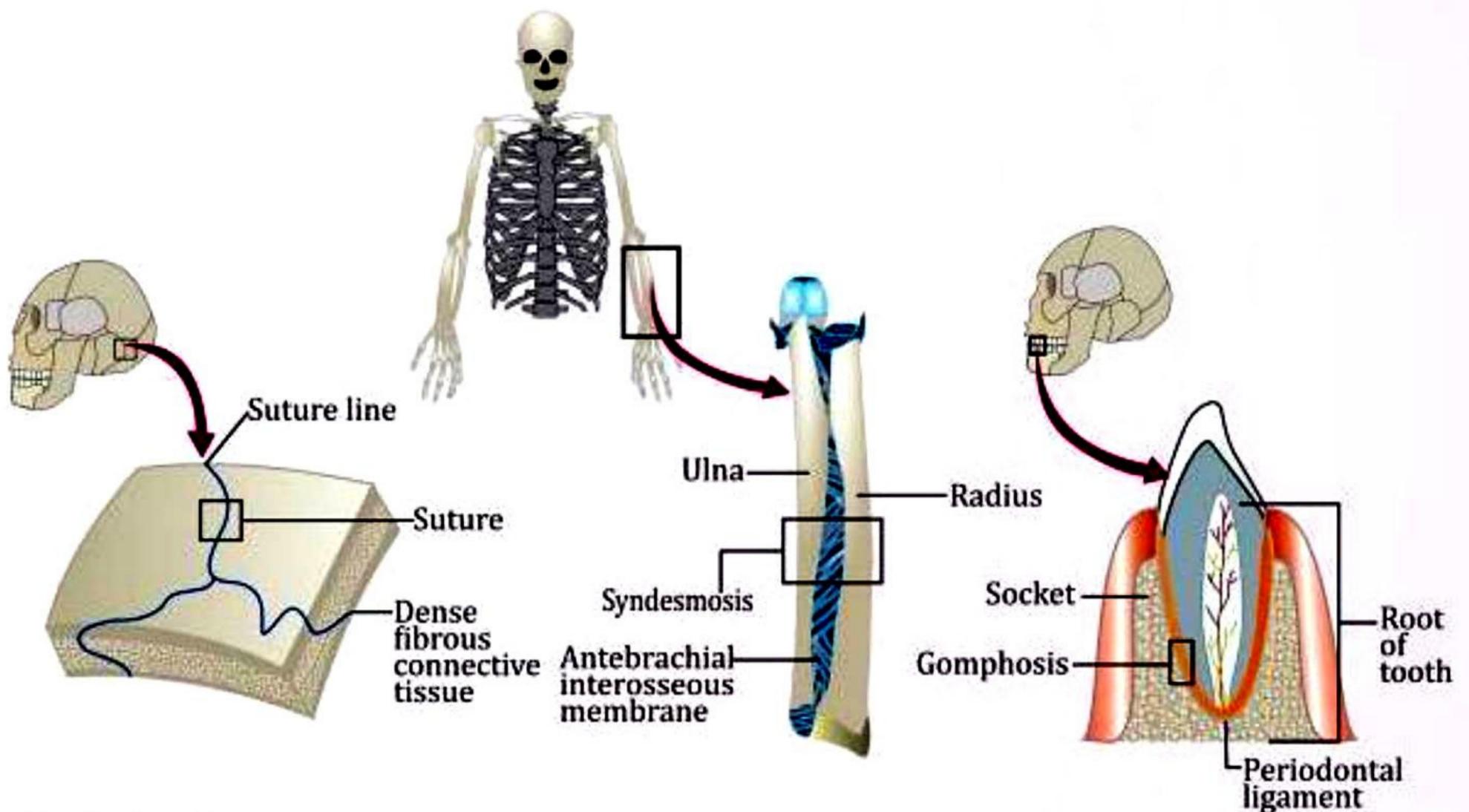
1. These are freely movable joints.
2. The enlargement of one bone fits into a depression of the other in this type of joint.
3. Synovial cavity (space between two bones) is lined by fibrous synovial membrane.
4. Synovial fluid is present between the joints which acts as a cushion to prevent friction between the joints. It is gelatinous in nature.
5. Articular cartilage (a layer of hyaline cartilage) covers the ends of the bones which provides smooth and elastic surface and reduces friction.

### Types of Synovial Joints

#### (a) Gliding Joints

## Characteristics

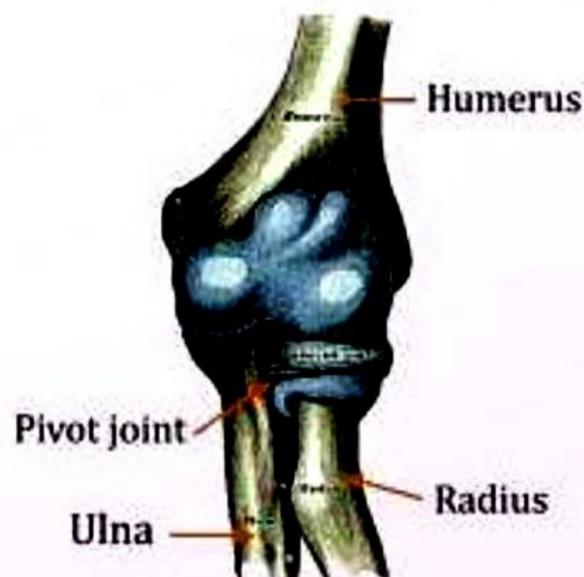
1. This joint allows limited movement in all directions as the bones are closely packed together or held in place by ligaments.
2. In this type of joint, an oval condyle of one bone fits into an elliptical concavity of the other.
3. No twisting is allowed as articular surfaces of gliding bones are flat. Back and forth and side to side movements are allowed, but only for a few joining elements.
4. Joints found in carpals of wrist and tarsals of ankle and foot are gliding joints.



## (b) Pivot Joints

### Characteristics

1. These joints are responsible for rotational movement between bones.
2. In this type of joint, rounded end of one bone fits into a shallow pit of another bone which remains stationary.
3. These joints are found between the atlas and axis vertebrae of backbone and also at the upper end of radius and ulna.



### (c) Hinge Joints

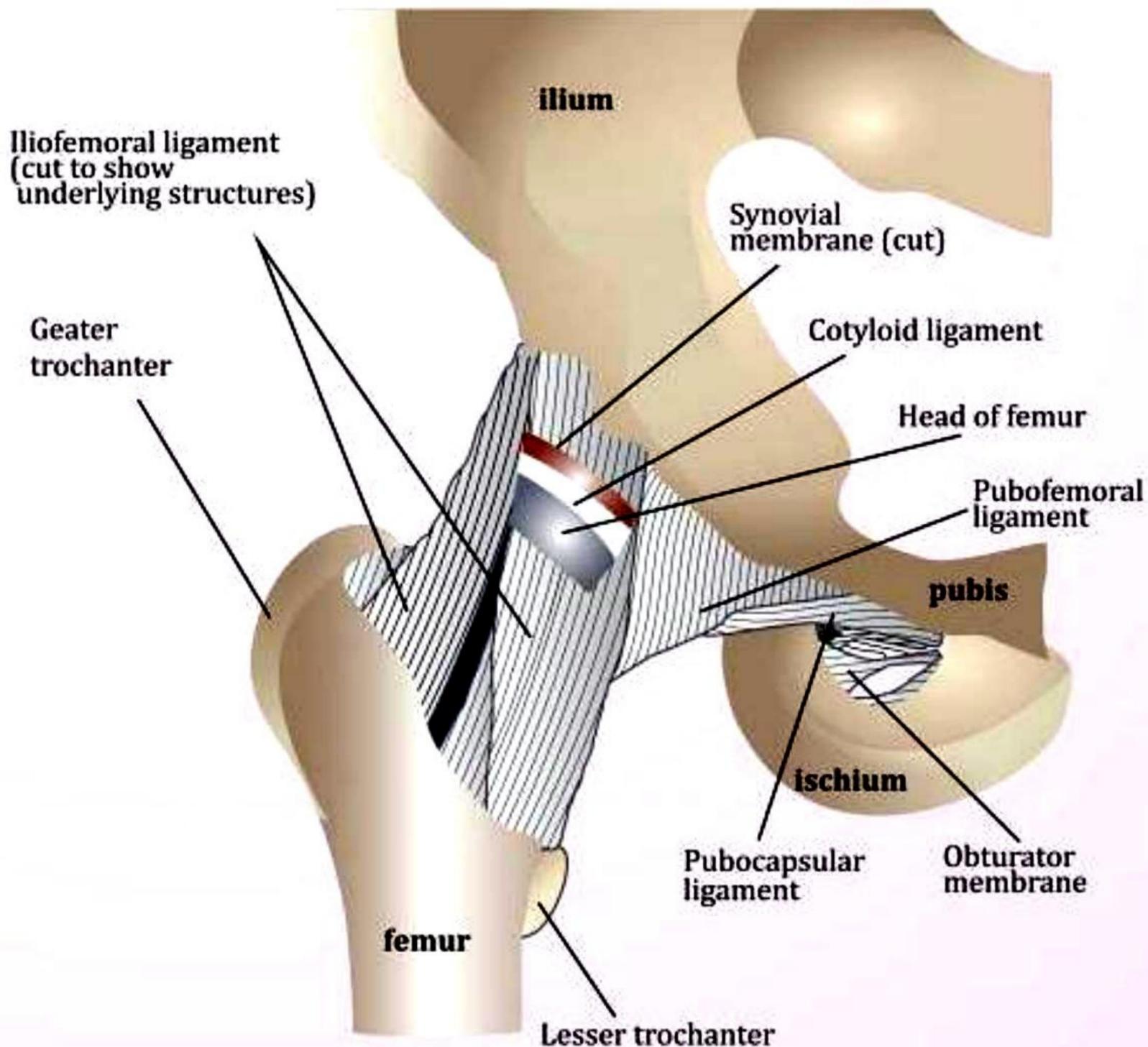
#### Characteristics

1. This joint allows the movement in one plane only and is held intact by ligament.
2. In this type of joint, one edge of the socket is prolonged to check the movement of ball in that direction.
3. This type of joint is found in knee joint, elbow joint, ankle joint and joints between phalanges or interphalangeal joints.

### (d) Ball and Socket Joints

#### Characteristics

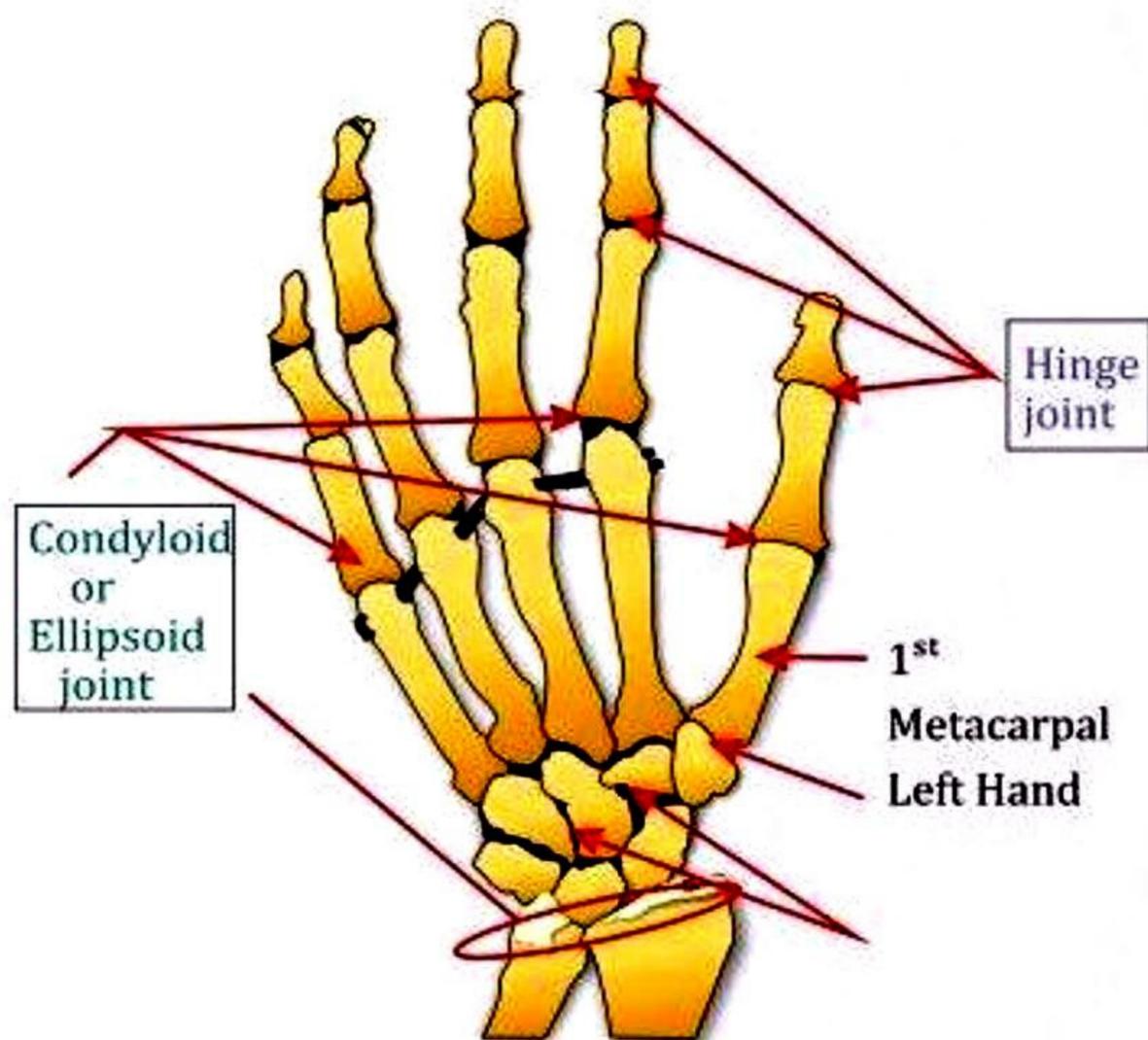
1. It is the most movable joint and can move freely in all planes or directions.
2. In this type of joint, a ball-like structure of one bone fits into a socket-like structure of another bone.
3. Movement at this joint may stretch, fold and rotate limbs and also can draw the limb towards or away from the body.
4. These joints are present between humerus with pectoral girdle, femur with pelvic girdle, and malleus with incus (in ear ossicles).



### (e) Saddle joints

#### Characteristics

1. These joints allow movement in two planes.
2. These resemble ball and socket joints but are less developed than the latter.
3. The ball in this joint is a small projection of one bone which fits into a saddle-like depression of another bone.
4. These joints are found in bones of metacarpals and carpals of thumb.



### PRECAUTIONS

1. Specimens should be handled carefully.
2. The joints must be observed and drawn carefully.

### VIVA VOCE

**Q1. Name the structure which connects a bone with cartilage.**

**Ans.** The place of articulation between two or more bones or between a bone and cartilage is called a joint.

**Q2. Where are the sutures or fibrous joints found?**

**Ans.** Sutures or fibrous joints are found in the skull of human beings.

**Q3. Name the disease occurring in younger children due to inflammation of joints.**

**Ans.** Still's disease is a kind of rheumatoid arthritis that occurs in younger people.

**Q4. Name the joints present between the vertebrae in vertebral column.**

**Ans.** Cartilaginous joints are present between vertebrae. They allow slight movement because of elastic

pads present between the ends of bones.

**Q5. Give an example of cartilaginous joints.**

**Ans.** Pubic symphysis and joints between the vertebrae of backbone are type of cartilaginous joints.

**Q6. Name the joint that can move freely.**

**Ans.** Synovial joints are freely movable joints that allow considerable movement and are surrounded by tubular articular capsule.

**Q7. Which substance is responsible for lubricating the freely movable joints?**

**Ans.** Synovial fluid is the thick sticky fluid that acts as a cushion to prevent friction between the joints by lubricating them.

**Q8. Name a disease of joints occurring in old age people. How is it caused?**

**Ans.** Osteoarthritis or degenerative joint disease is characterized by progressive erosion of articular cartilage known as synovial joint. It is commonly seen in old age people because the secretion of synovial fluid in the joints decreases with age.

**Q9. Which joint allows the movement of bone only in a single plane?**

**Ans.** Hinge joint present in elbow and knee shows or permits movement in a single plane only.

**Q10. Which type of joint is found in hip or pelvic bones that makes it movable?**

**Ans.** Ball and socket joint is present in hip or pelvic bones that makes it movable.

**Q11. Name a joint allowing rotational movement of bones.**

**Ans.** The joint that allows rotatory movement of one bone on the other stationary bone is called pivot joint, e.g. atlas and axis vertebrae of backbone show pivot joints.

**Q12. Which type of joints in human body permit movement in two planes?**

**Ans.** Those joints that allow movement in two planes and are less developed form of ball and socket joints are called saddle joint.

**Q13. Why is the stiffness of joints seen in old age?**

**Ans.** In old age, the stiffness of joints is due to the decrease in synovial fluid.