Chapter

1

Basic Anatomy

THE SKELETON

The skeleton (Fig. 1.1) is made up of a large number of bones some of which are single and others paired. They are of various size and shape, can be classified into five main groups.

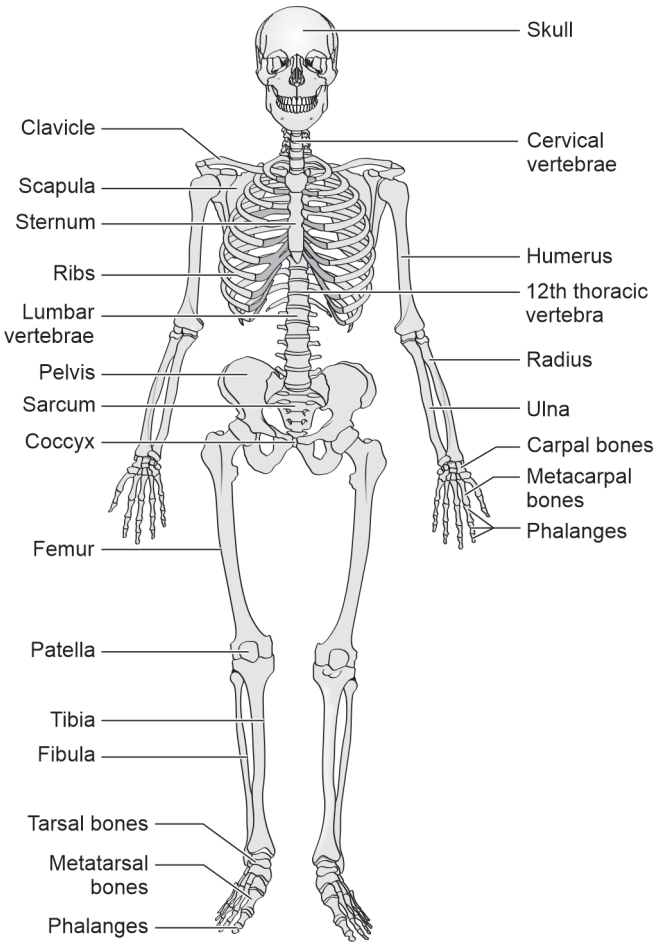

Fig. 1.1: Human skeleton

(a) Long bones in general are cylindrical with an expanded ends on either side. Usually all the limb bones belong to this group. (b) Short bones vary in shape. They include the bones of the proximal portions of the hands and feet (carpal and tarsal bones). (c) Flat bones have large surface area compared to their depth and include the bones of the skull vault and the ribs. (d) Irregular bones are those of spinal column and (e) Sesamoid bones are small bones present in tendons near joints (patella).

STRUCTURE OF BONE

Bone is a hardest connective tissue. It consists of an organic matrix in which inorganic salts are deposited. These salts provides rigidity to bones and constitute mainly calcium and phosphate with some magnesium and carbonate. A fibrous membrane, the periosteum, covers the outer surface of bones except for those areas that form moving joints, where the bone is covered with articular cartilage. A network of blood vessels is present in periosteum which penetrates into the underlying bone. A cross-section (Fig. 1.1) of bone reveals that they are of two type:

1. Compact bone (Fig. 1.2a and b) on seeing it appears to be dense and structureless and this makes up the outer layer of a bone.

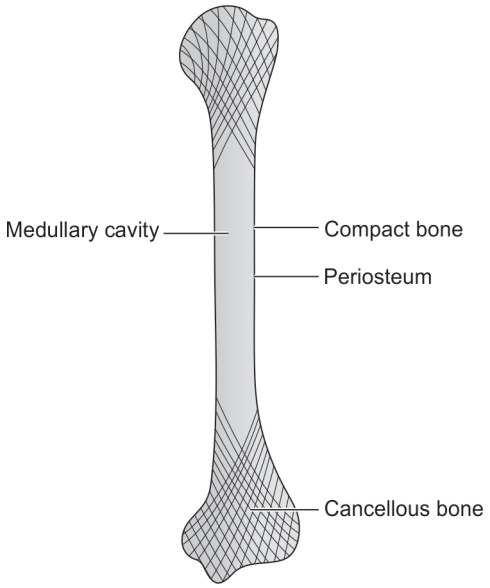

Fig. 1.2a: Longitudinal section of a long bone

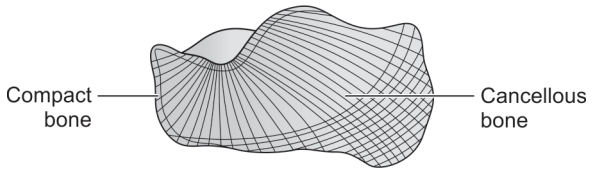

Fig. 1.2b: Longitudinal section of a short bone

2. Spongy bone, which consists of strands of bone called trabeculae, with interversing spaces that are visible to the naked eye.

On viewing the compact bone under the microscope, a regular arrangement of units called Haversian system (Figs 1.3 and 1.4) is present, whereas spongy bones contain lamelles.

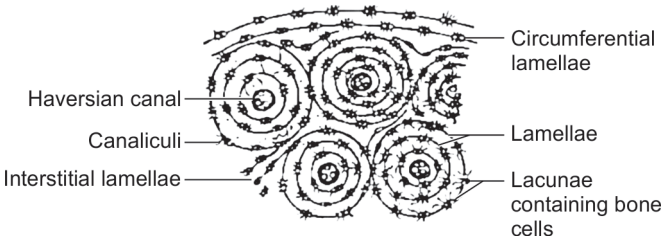

Fig. 1.3: Transverse section of compact bone

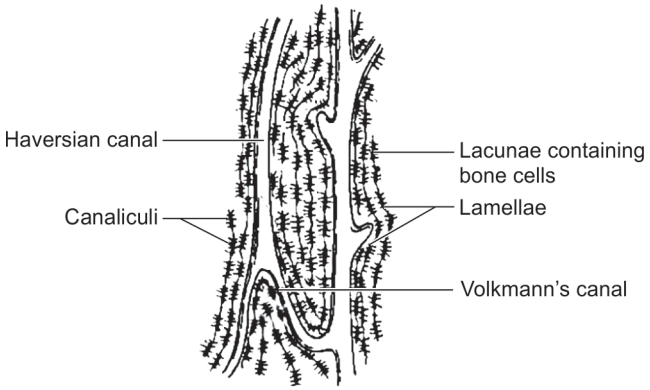

Fig. 1.4: Longitudinal section of compact bone

THE SKULL

The skull is the name given to the bones which make up the skeleton of the head. The only bone of the skull which is movable is the mandible or lower jaw. The rest of the bones are firmly joined together with joints known as sutures. When skull is viewed from above it appears (Fig. 1.5) oval in outline along with number of bone and sutures whereas the frontal view (Fig. 1.6) of skull along with orbit appears to be different as shown in Fig. 1.7, the skull viewed from side (Fig. 1.8) and below (Fig. 1.9) can be seen. When looked from below (base) this further can be explained as, anterior part of the base (with hard palate and the alveolar process of the maxillae), middle part of the base, extends from the posterior margin of the hard palate to the anterior margin of the foramen magnum. As one could see that this part of skull consists of many important foramens (Fig. 1.9). Also the posterior part of the base could be seen in this figure.

The interior of the skull (Fig. 1.10) can be examined by removing the top of the vault the skull cap. It is formed anteriorly by frontal bone on each side by the left and the right parietal bones and posteriorly by a small portion of the occipital bone. The coronal

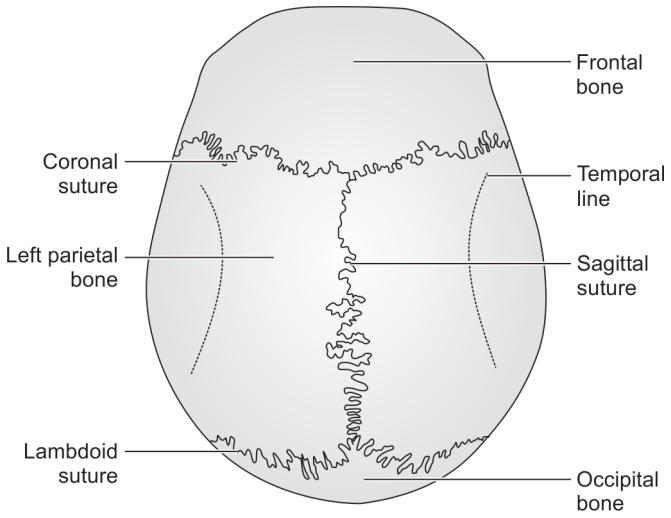

Fig. 1.5: The skull seen from above

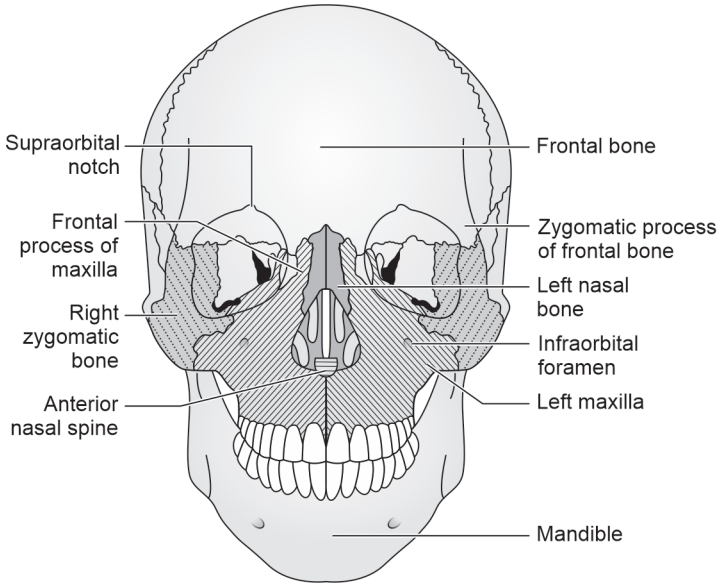

Fig. 1.6: The skull seen from the front

and sagittal sutures and a small part of the lambdoid suture can usually be seen on the interior of the skull cap, but with advancing age they may be obliterated.

The interior of the base of the skull (Fig. 1.10) is subdivided into anterior, middle and posterior cranial fossae. The anterior craniun is formed mostly by the frontal bone (Fig. 1.11), the lesser wings of the sphenoid forms the posterior edge of the floor. The cribriform plate of the ethmoid bone forms a small part of the floor in the midline. The anterior fossa is a higher level than middle cranial fossa and is separated by the optic groove. The middle cranial fossa (Fig. 1.12) is formed by the body, greater wings of the sphenoid bone and by the temporal bones.

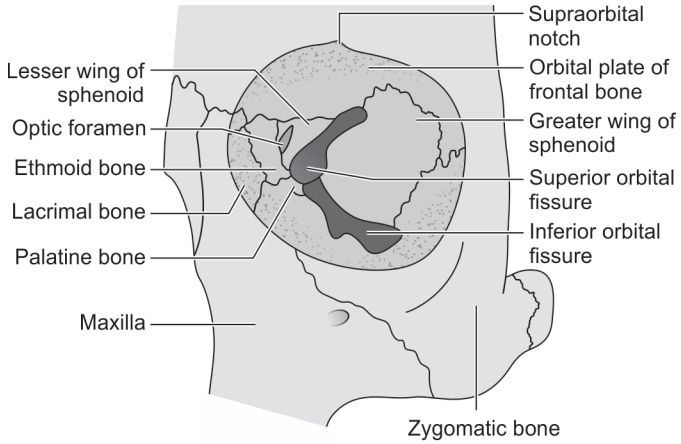

Fig. 1.7: The left orbit seen from the front

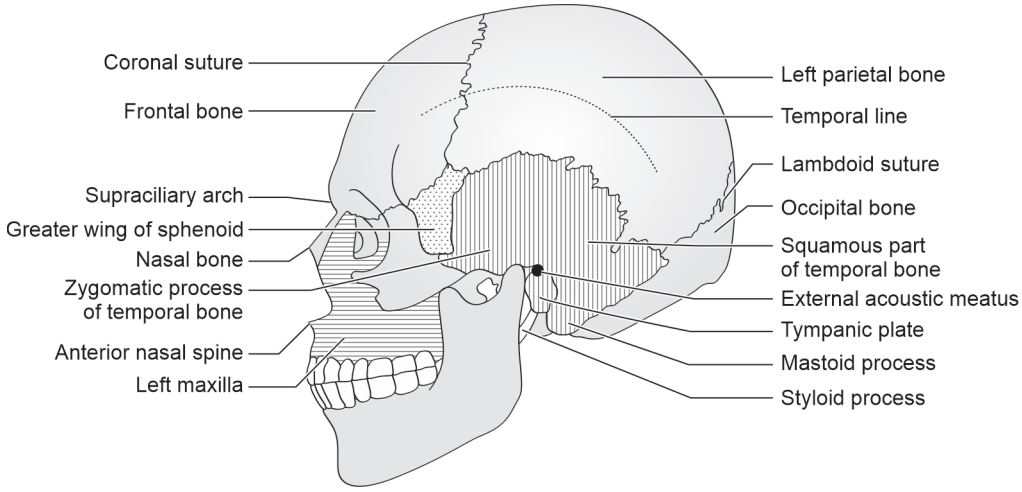

Fig. 1.8: The skull seen from the left side

Its posterior border is formed by the upper border of the petrous portions of the temporal bones. The posterior cranial fossa (Fig. 1.13) is formed mainly by the occipital and temporal bones. The various foramens and grooves for sinuses could be seen in these fossae (Figs 1.12 and 1.13).

The nasal cavity is an irregularly shaped cavity which lies above the floor of the mouth and below the anterior cranial fossa. It is divided into right and left halves by the nasal septum (Fig. 1.14). The anterior part of the septum is formed in the living body by a cartilaginous plate so that when the skull is examined there is only a single anterior opening to the nasal cavity. Opening into the nasal cavity are the paranasal sinuses. These paranasal sinuses communicate with the nasal cavity and are lined with mucous membrane. The sinuses are present in frontal bone (the frontal sinuses), the maxillae (the maxillary sinuses), the ethmoid bone (the ethmoidal sinuses) and the sphenoid bone (the sphenoid sinuses) (Fig. 1.15). These sinuses are virtually absent at birth but gradually enlarge during childhood and puberty. Even their size varies in individuals.

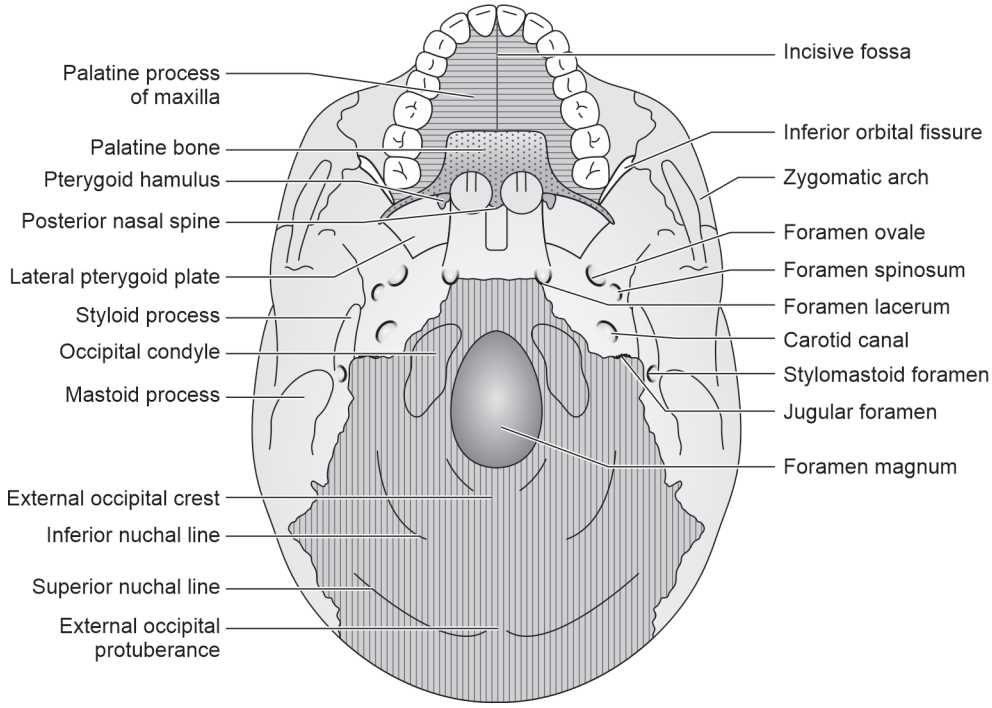

Fig. 1.9: Base of the skull

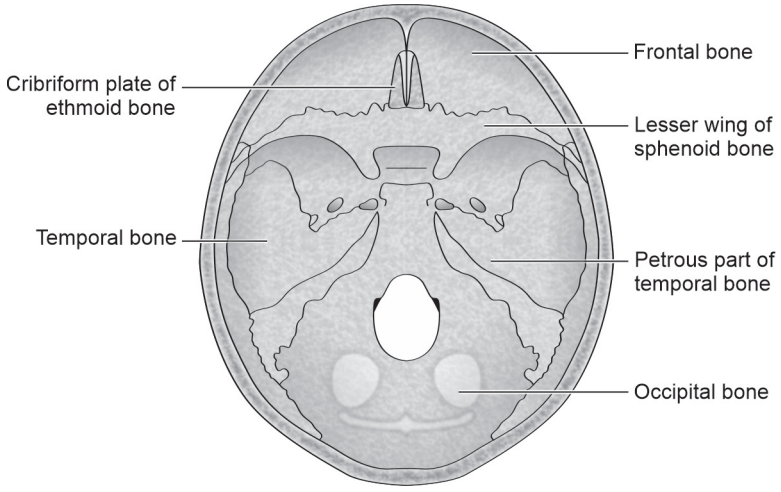

Fig. 1.10: Interior of the base of the skull

The Vertebral Column

The vertebral column forms the central axis of the trunk. It is composed of 33 bones called vertebra (Fig. 1.16). Each bone is connected to each other forming joints at which small range of movements are possible. The vertebral column is divided into five regions (Fig. 1.16). A vertebra is composed of two parts, an anterior part called the body (Fig. 1.17a)

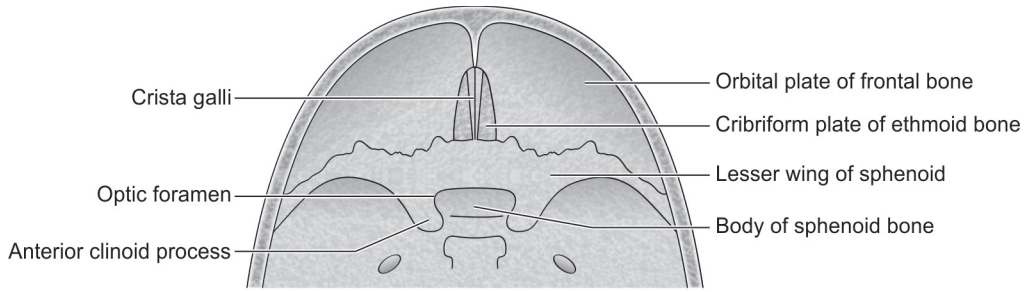

Fig. 1.11: Anterior cranial fossa

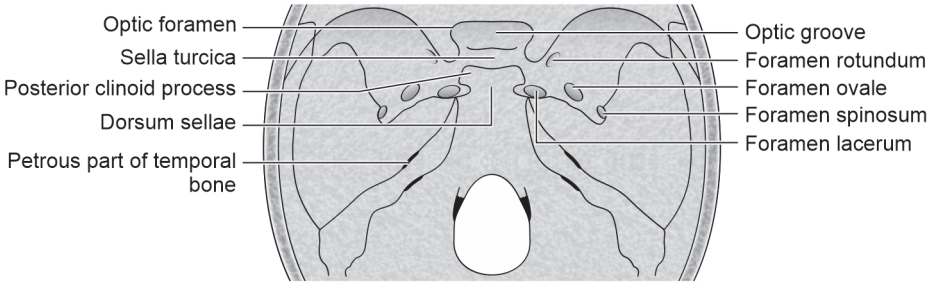

Fig. 1.12: Middle cranial fossa

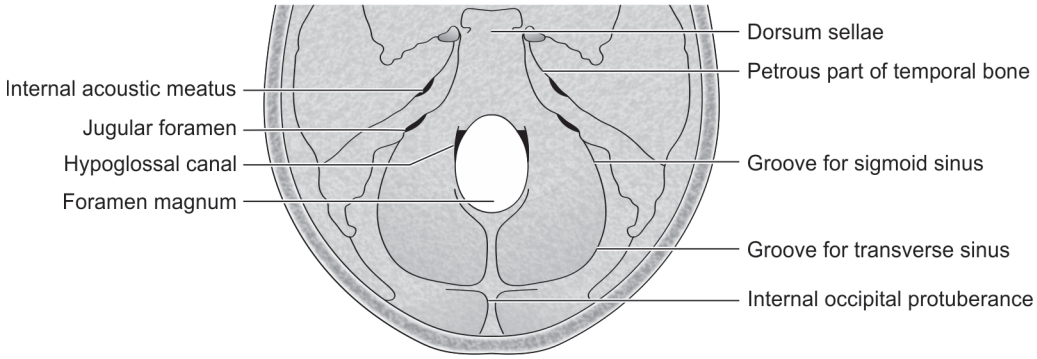

Fig. 1.13: Posterior cranial fossa

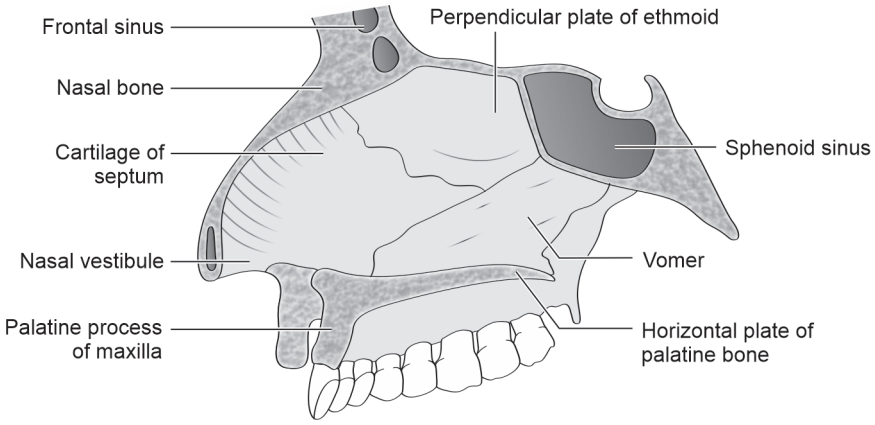

Fig. 1.14: Nasal septum

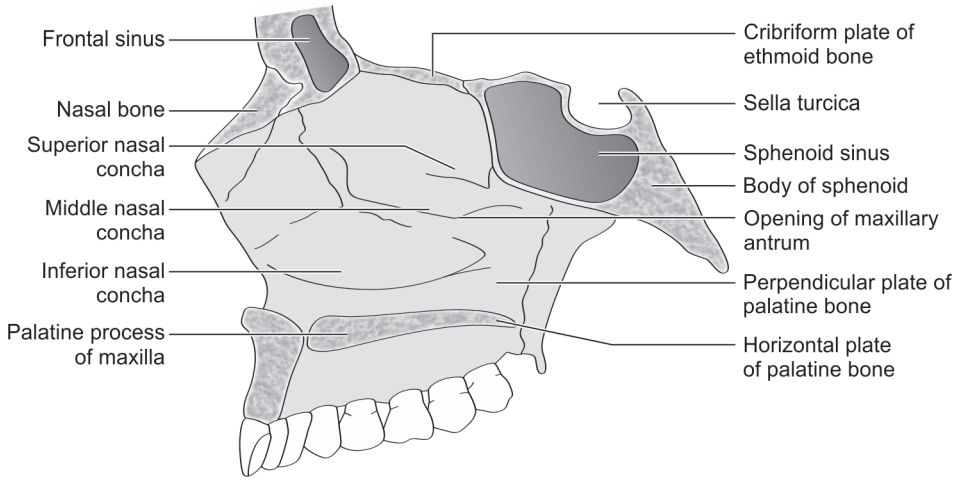

Fig. 1.15: Lateral wall of the nasal cavity

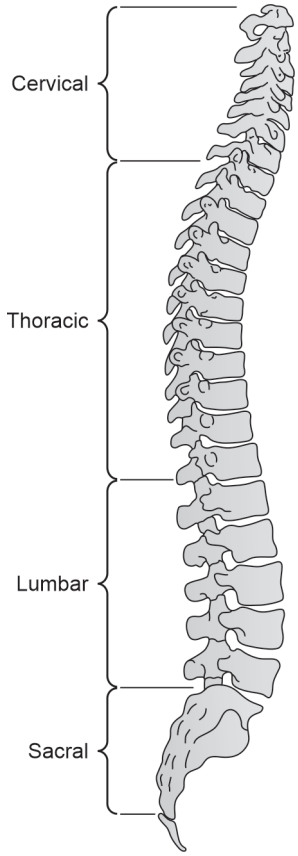

Fig. 1.16: Vertebral column

and the arch encloses a foramen called the vertebral foramen through which the spinal cord runs. The distribution of vertebrae in each division is shown in Fig. 1.16. A typical lateral and superior views of cervical, thoracic, lumbar vertebra are shown in Figs 1.17, 1.18a and b and 1.19a and b.

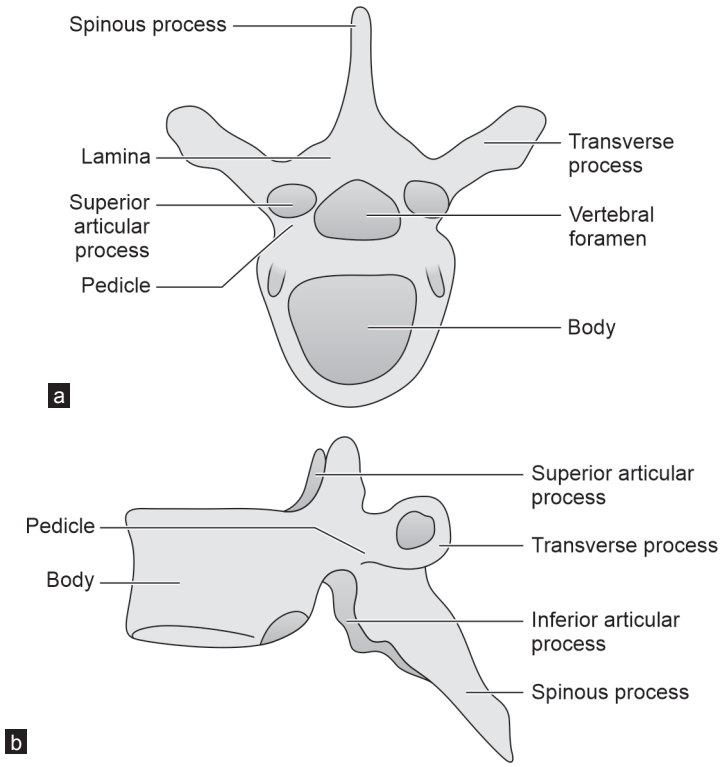

Fig. 1.17: A typical vertebra: (a) superior view, and (b) lateral view

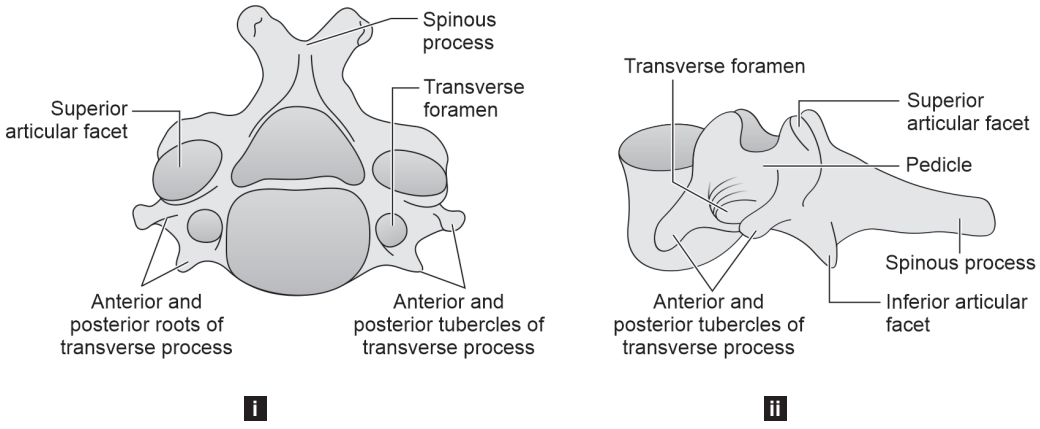

Fig. 1.18a: A typical cervical vertebra: (i) superior view, and (ii) lateral view

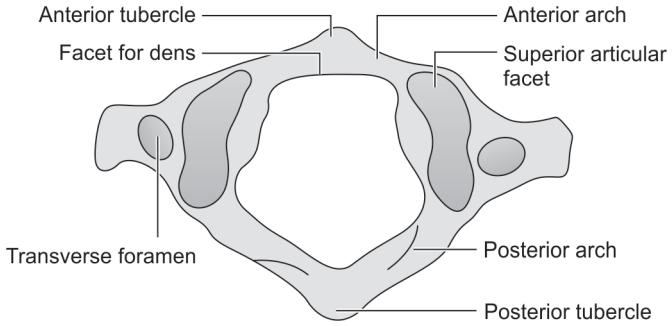

Fig. 1.18b: The atlas, superior aspect

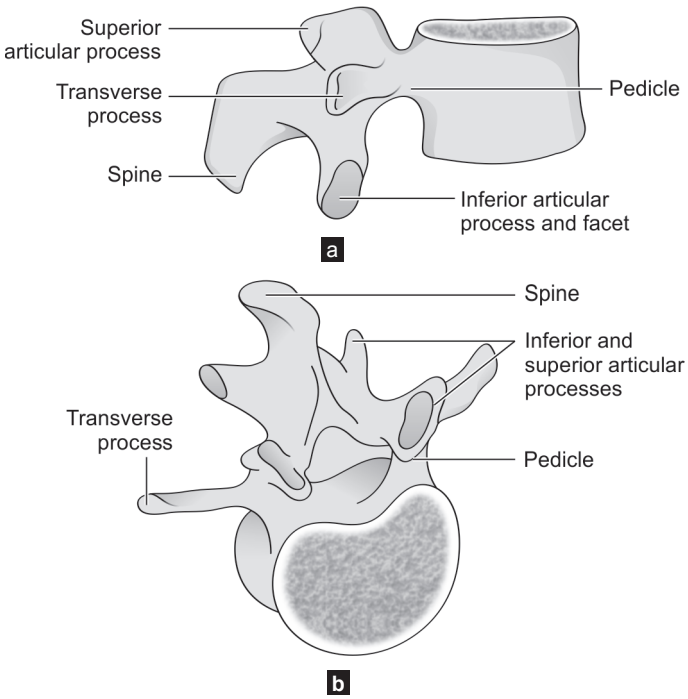

Fig. 1.19: A typical lumbar vertebra: (a) lateral aspect, (b) anterosuperior aspect

The sacrum is composed of five vertebrae (Fig. 1.20a and b). In adult, these are completely fused to form a single unit. The sacrum together with the coccyx forms the posterior wall of the bony pelvis. The sacrum is roughly triangular in shape and has anterior, posterior (Fig. 1.20a) and lateral surfaces, a base which lies superiorly and an apex lies inferiorly, the coccyx is a small triangular bone, composed of four (occasionally three or five) fused vertebra.

The ribs, twelve on each side, constitute the greater part of the bony wall of the thorax (Fig. 1.21 lung and pleura). The sternum is quadrilateral in shape and is wider (Fig. 1.21) above than below.

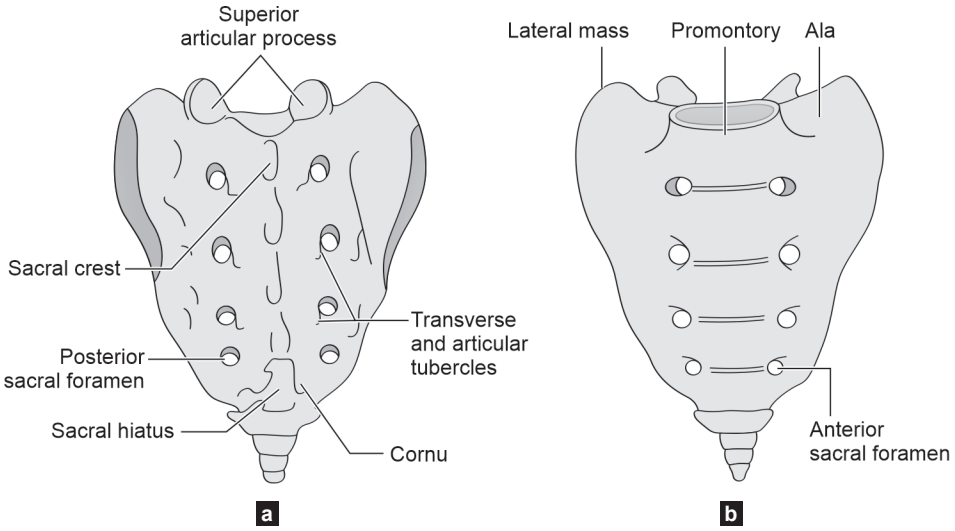

Fig. 1.20: The sacrum and coccyx: (a) posterior aspect, and (b) anterior aspect

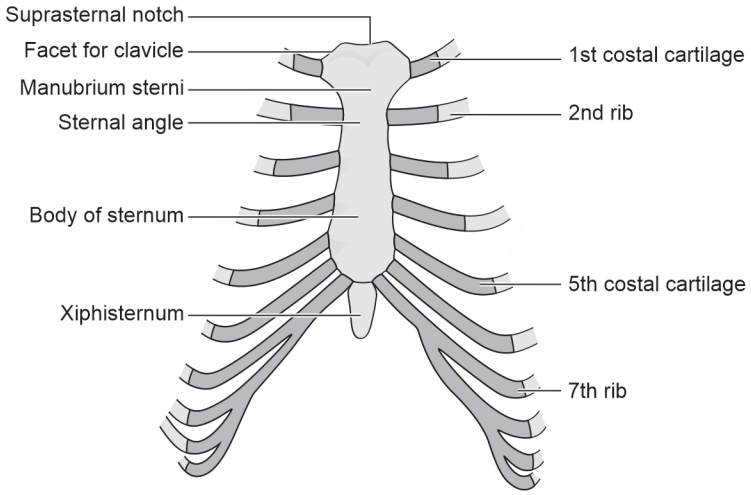

Fig. 1.21: The sternum and the costal cartilages

The Bones of Upper Extremities

The upper limb is attached to the trunk by the shoulder girdle is made up of two bones the clavicle anteriorly and the scapula posteriorly. Shoulder girdle is attached to trunk by one joint, the sternoclavicular joint and by muscles. The upper limb can further be divided into three segments: (1) the upper arm has one bone, the humerus. (2) the forearm, has two bones the radius and the ulna. (3) the wrist and hand are made up of eight carpal bones, five metacarpal bones and 14 phalanges.

The clavicle (Fig. 1.22a and b) or collar bone is a long ' S ' shape bone. It differs from other long bones in two ways as it has no medullary cavity and it is ossified membrane. The medial end articulates with the sternum to form sternoclavicular joint, whereas the lateral end articulates with the acromian process of the scapula (acromioclavicular joint).

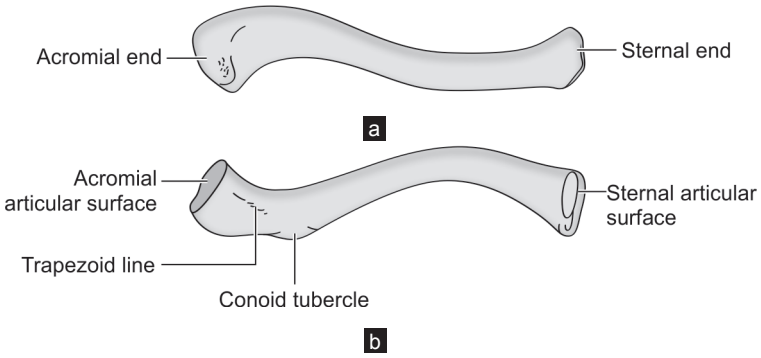

Fig. 1.22: The right clavicle: (a) superior aspect, and (b) inferior aspect 'S' shape

The scapula (Fig. 1.23) or shoulder blade, is the posterior bone of the shoulder girdle. It is a flattened triangular bone, at a lateral angle of which is an expanded portion, the head of the scapula. This bears the glenoid cavity which articulates with the head of a humerus at the shoulder joint.

The posterior surface of the body is divided into two parts by the spine of the scapula, which widens out at its lateral end to form the acromion process. The humerus is largest (long) bone of upper limb. The head (Fig. 1.24a) of the humerus is the most prominent feature of the upper end. While articulating with scapula forms half a sphere (Fig. 1.24b). The lower end is triangular and is flattened from front to back. The two angles of the triangle are formed by the medial (thicker) and lateral epicondyles. The shaft of the humerus is cylindrical in its upper two-thirds, but the lower third is flattened from front to back. On the anterolateral surface of the shaft is a roughened projection which extends half way down the shaft (deltoid tuberosity) gives attachment to the deltoid muscle.

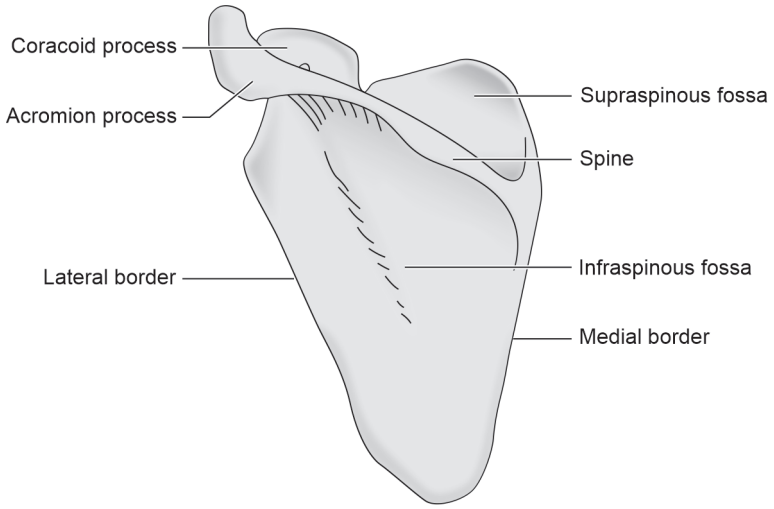

Fig. 1.23a: The left scapula, posterior aspect

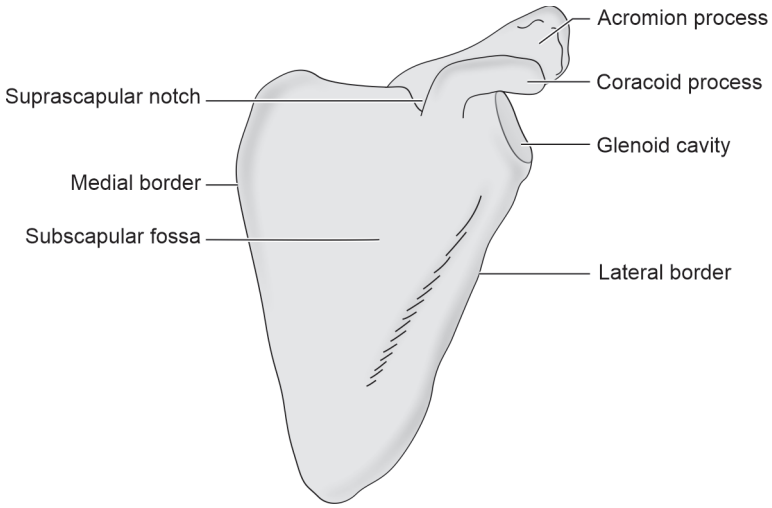

Fig. 1.23b: The left scapula, anterior aspect

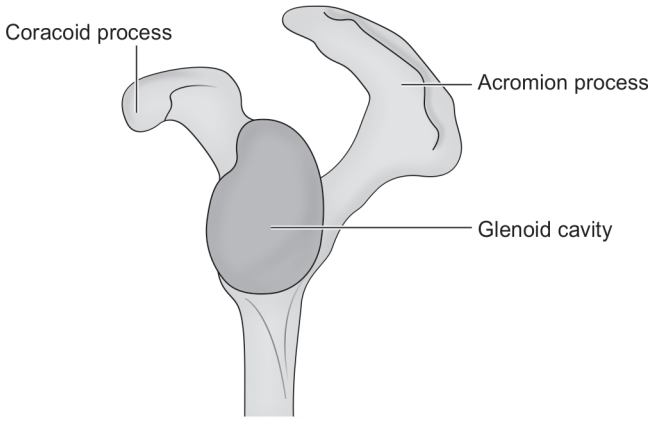

Fig. 1.23c: The left scapula, lateral aspect of the upper part

The Radius and Ulna

The radius is the lateral and long bone of forearm having shaft (Fig. 1.25a and b) a small circular upper end and a wider lower end. The ulna is a medial and longer bone of the forearm (Fig. 1.25a and b) having shaft too. It has wider upper end and a small rounded lower end. The carpal bones are eight small (Fig. 1.26a) bones arranged in a proximal and a distal row. Those of the proximal row are named from lateral to medial side (the scaphoid to pisiform) whereas the distal row are named from the lateral to the medial side (the trapezium to the hamate).

The metacarpal bones, five in number are miniature long bones. They are (Fig. 1.26a and b) composed of a rounded head which lies distally, a shaft and an expanded proximal end called the base.

The phalanges (Fig. 1.26a and b) 14 in number, three for each four fingers and two for the thumb. The phalanges of each finger are referred to as the proximal, middle and distal phalanges.

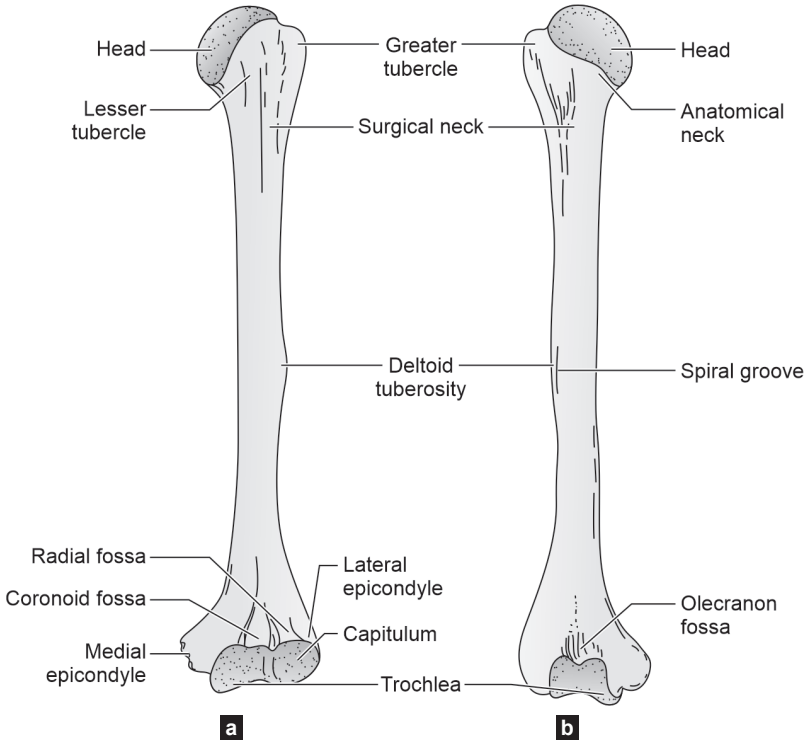

Fig. 1.24: The left humerus: (a) anterior aspect, (b) posterior aspect

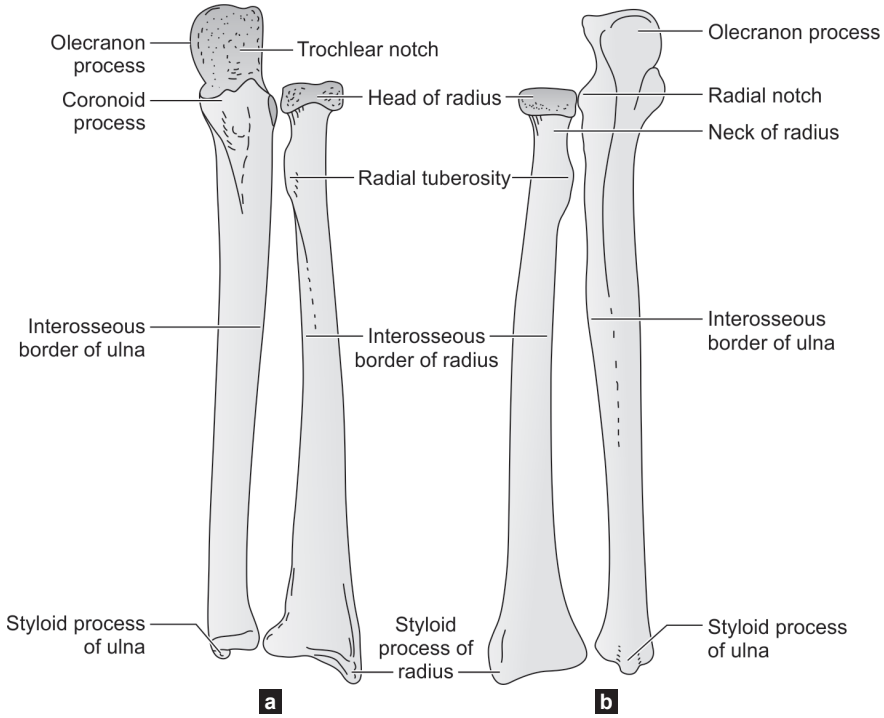

Fig. 1.25: The left radius and ulna: (a) anterior aspect, and (b) posterior aspect

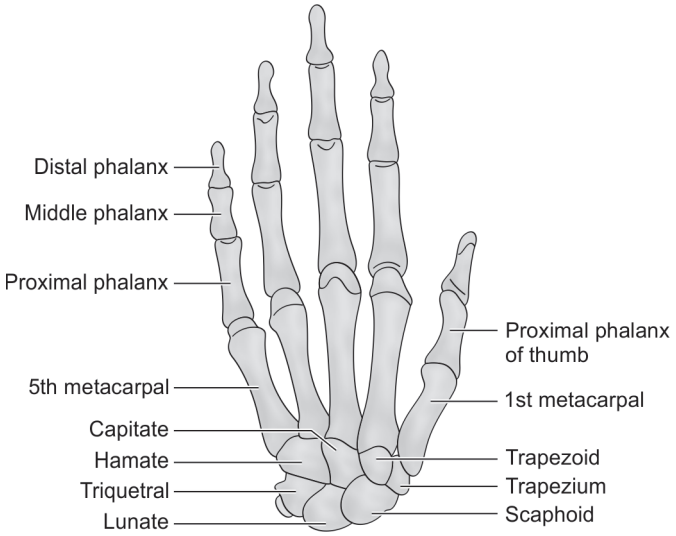

Fig. 1.26a: The left hand, dorsal aspect

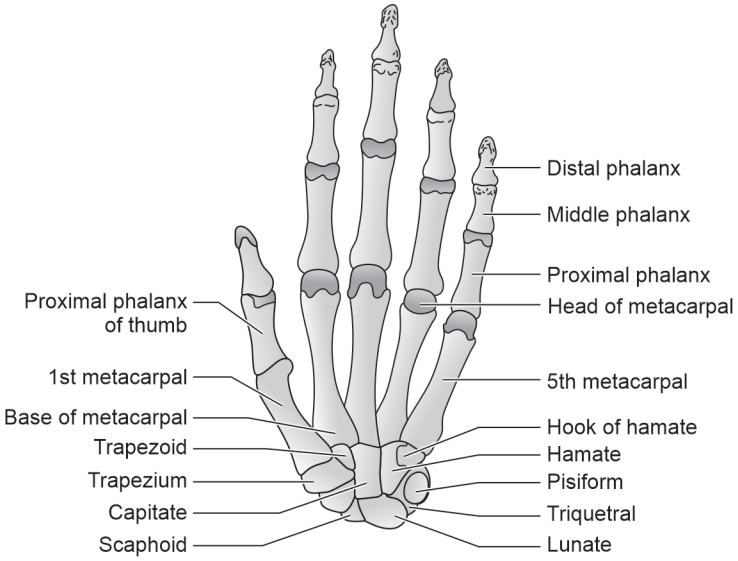

Fig. 1.26b: The left hand, palmar aspect

The Bones of the Lower Extremity

Similar to upper limb, lower limb is also composed of three segments:

1. The thigh
2. The leg and
3. The feet

The hip bone is large irregular shaped bone, constricted in its middle and expanded above and below (Fig. 1.27). The lateral surface of the hip bone bears, near its middle a large cup shaped structure called the acetabulum which forms a socket for articulation

with the head of the femur at the hip joint. The expanded portion of the bone, below the acetabulum is pierced by a large foramen called the obturator foramen. Above the acetabulum is a wide, flat plate of bone which has an upper curve border called the iliac crest.

Each hip bone is composed of three portions called the ilium, the ischium and the pubis. In the child these portions are joined by cartilage, but by adult life the bony fusion is taking place (the line of fusion of the three parts are shown by dotted lines, Fig. 1.27a). The internal aspect of the left hip bone is shown in Fig. 1.27b.

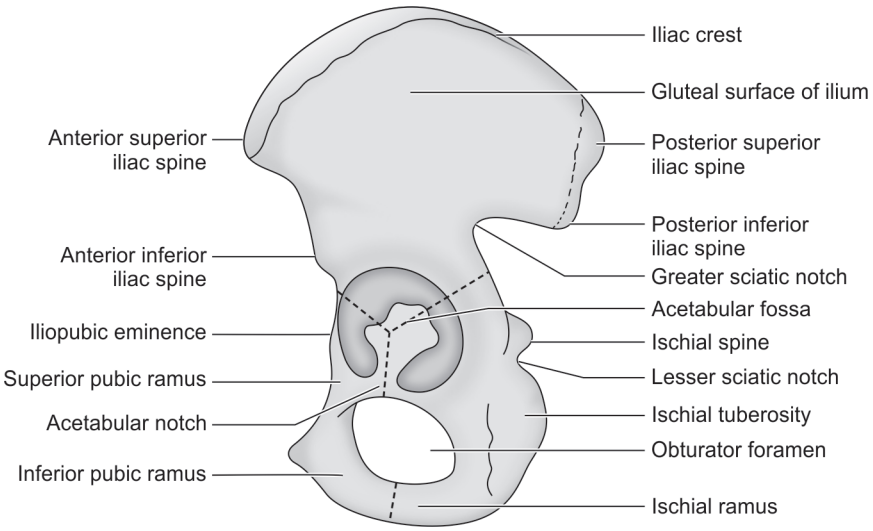

Fig. 1.27a: External aspect of the left hip bone

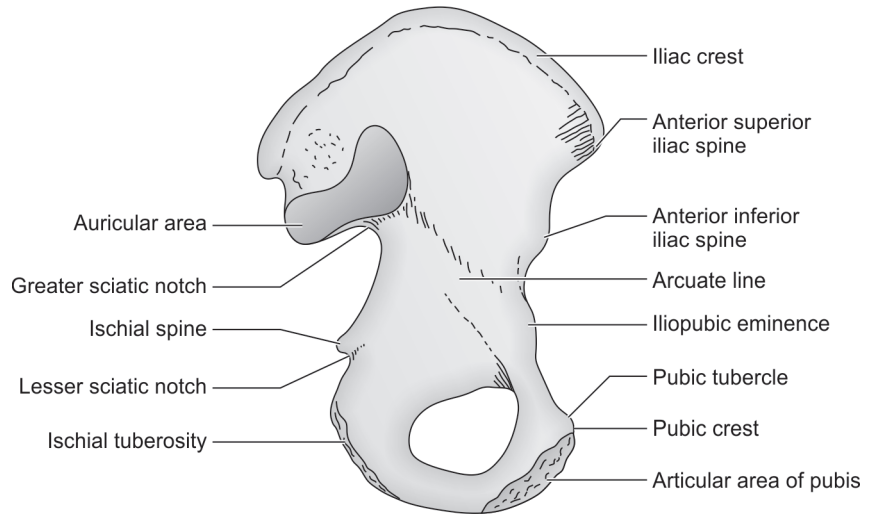

Fig.1.27b: Internal aspect of the left hip bone

The pelvis is a ring of bone which is placed between the lower part of the vertebral column and the lower limbs. It is formed (Fig. 1.28) posteriorly by the sacrum and anteriorly and laterally by two hip bones. It transfers the weight of the trunk and upper limbs from the vertebral column to the lower limbs. The pelvis is divided into upper (false pelvis) and lower (true pelvis) ones. The inlet of the pelvis is slightly heart-shaped in male but is more circular in female (Fig. 1.28a and b). The outlet of the pelvis is the lower margin and is formed anteriorly by the lower border of the symphysis pubis, laterally by the ischial tuberosities and posteriorly by the tip of the coccyx. The anterior margins of the outlet pelvis are formed by the inferior pubic rami which meet at an angle called pubic arch (Fig. 1.28c). The cavity of the true pelvis is a curved canal which is deeper behind than in front and it follows the curvature of the sacrum and coccyx.

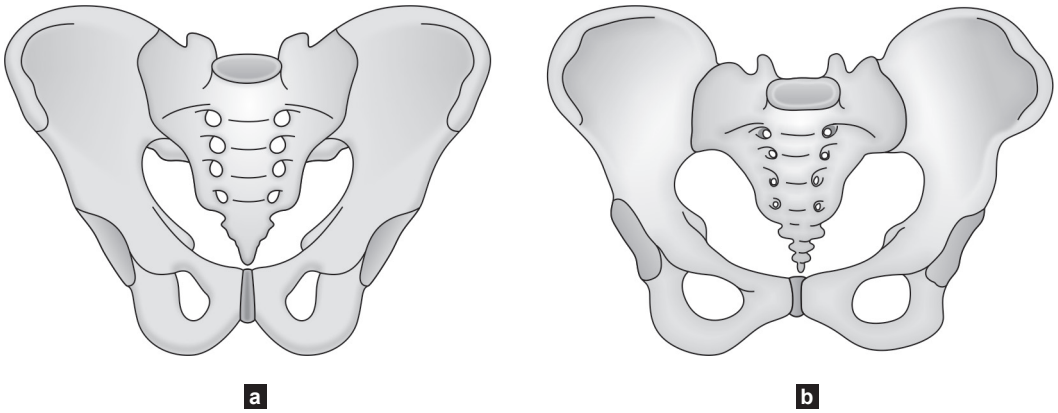

Fig. 1.28: (a) Male, and (b) Female pelvis

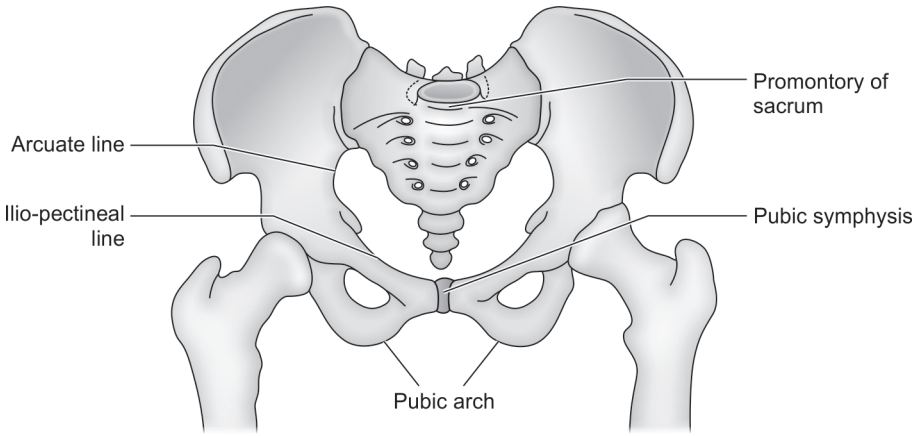

Fig. 1.28c: The pelvis, anterior aspect

The femur is one of the longest and strongest bone in the body (Fig. 1.29). It consists of an upper end, lower end and a shaft. In the articulated skeleton, the femur lie obliquely, their upper ends are separated by that width of the pelvis but their lower ends are in close proximity at the knees. The upper end of femur consists of head, neck, lesser and greater trochanters (Fig. 1.29a). The lower end of the femur is expanded and is composed

of two masses of bone called the condyles. The condyles are joined anteriorly but are separated posteriorly by a U-shaped notch, called the intercondylar notch (Fig. 1.29b).

The patella or knee cap is the largest sesamoid bone in the body. It is almost triangular in shape (Fig. 1.30a and b) with the prominent rounded apex lying inferiorly. The ligamentum patellae is attached to the apex of the patella. The lateral and medial borders of the patella are rounded and well defined. The superior border or base of the patella is thickened. Downwards and forwards lies the tibia which is one of the long bone. Medially it is related to fibula. Tibia (Fig. 1.31a and b) consists of an upper expanded end, a smaller lower end and a shaft.

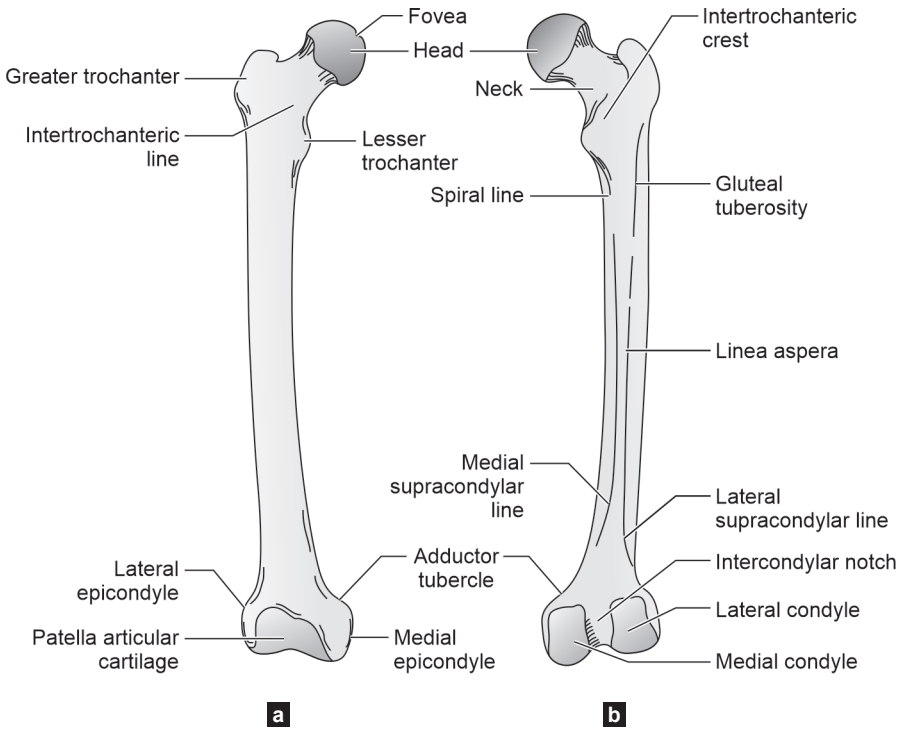

Fig. 1.29: The right femur: (a) anterior aspect, and (b) posterior aspect

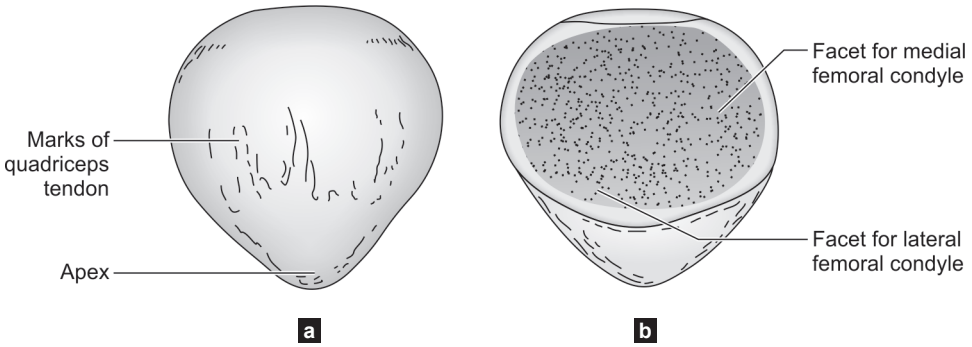

Fig. 1.30: The left patella: (a) anterior aspect, and (b) posterior aspect

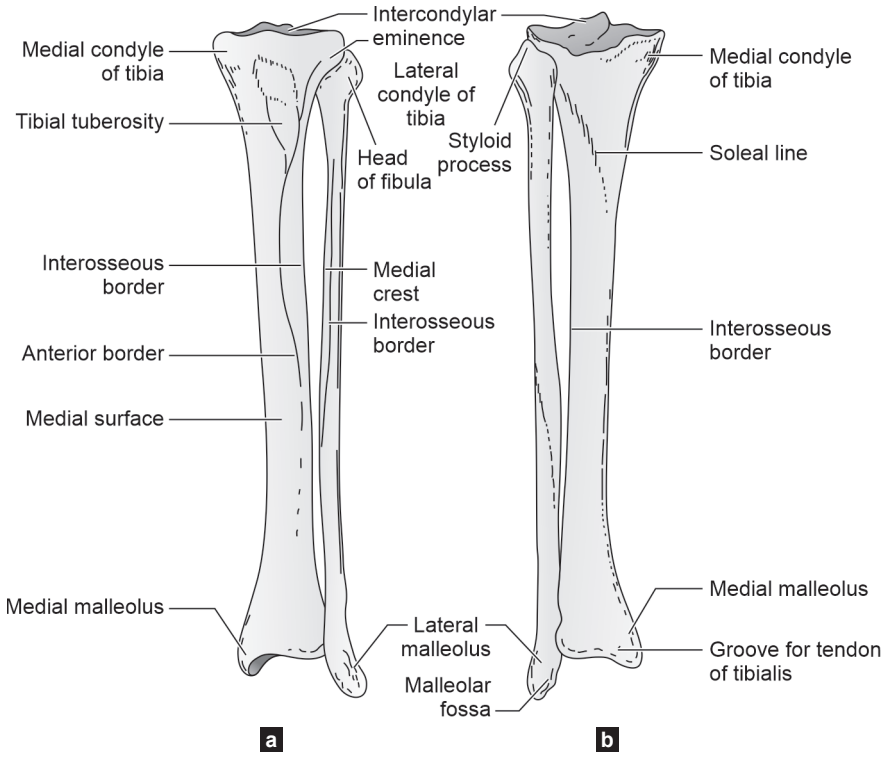

Fig. 1.31: The tibia and fibula: (a) anterior aspect, and (b) posterior aspect

The fibula (Fig. 1.31a and b) is the lateral bone along with tibia of leg is shorter and more slender than the tibia. It is composed of an upper end head, a lower end, forms lateral malleolus and a shaft.

The tarsal bones are seven in number with irregular shape. They correspond to the carpal bones of the hand (Fig. 1.32) but they are considerably larger and are modified for bearing the weight of the body. They are talus, calcaneum, cuboid, navicular, medial, intermediate and lateral cuneiform bones, arranged as shown in Fig. 1.32a to d.

The Metatarsal Bones

There are five metatarsal bones. They are long bones having a base proximally, a head distally and a shaft. The 2nd, 3rd and 4th metatarsals are similar but the 1st and 5th differ (Fig. 1.32a and b). As the bases are wedge shaped are wider above than below. Their shape and articulations are shown in the above figure.

The phalanges are two for the 1st (big) toe (proximal and middle) and three phalanges for each of the other toes. The middle and distal phalanges of the 5th toe are however frequently fused to form one bone (Fig. 1.32a and b).

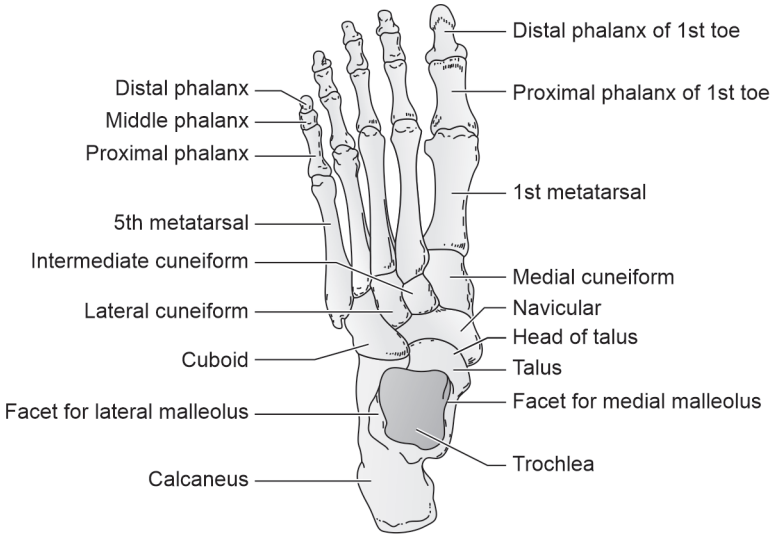

Fig. 1.32a: The left foot, dorsal aspect

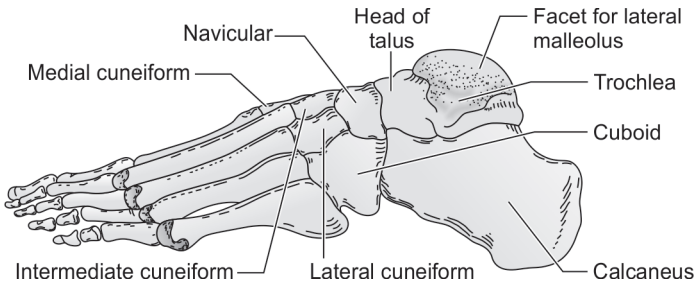

Fig. 1.32b: The left foot, lateral aspect

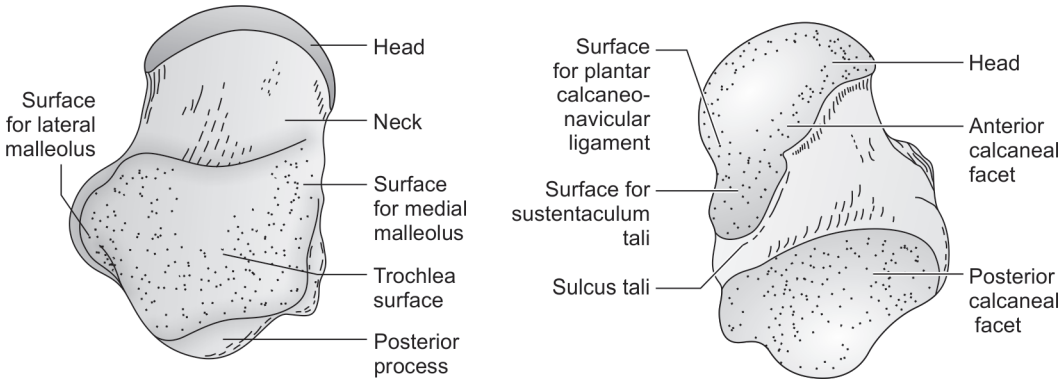

Fig. 1.32c and d: The left talus: (c) superior aspect, and (d) inferior aspect