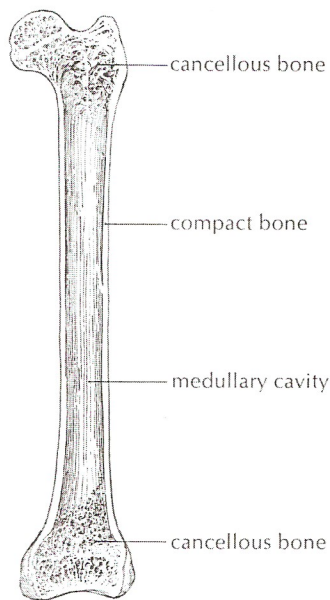


THE SKELETON

STRUCTURE OF BONE



longitudinal section of femur

Examine a longitudinal section of the femur and observe that the shaft consists of a hollow tube of compact osseous tissue, and that the proximal and distal ends of the bone are filled by a network of slender bony spicules. Such networks are termed cancellous bone. Most bones consist of compact and cancellous bone, combined to provide optimum strength with a minimum of material.

A fibrous membrane, the periosteum, covers the surface of each bone, being absent only at the cartilaginous articulating surfaces. The interstices of the cancellous bone and the medullary cavities of the long bones contain marrow. Each bone is supplied by arteries, veins, and lymphatics, which pass through nutrient foramina to reach the marrow.

Bones are united by the following types of joints:

Immovable (synarthroses). Example: the sutures of the skull, in which the bones are held together by interlocking margins united by fibrous tissue.

Movable (diarthroses). Example: the knee, in which the opposing ends of the bones are covered by articular cartilage and are held together by ligaments lined by synovial membrane. This type includes most of the joints.

Slightly movable (amphiarthroses). Example: the articulations between the bodies of the vertebrae, in which the bones are held together by flattened disks of fibrocartilage.

Examine a mounted skeleton and familiarize yourself with the bones illustrated in Figure 1.

For descriptive purposes the skeleton may be divided into the axial skeleton, consisting of the skull, vertebral column, ribs, and sternum; and the appendicular skeleton, consisting of the pectoral girdle, pelvic girdle, and limb bones.

Examine a skull and refer to Figures 2 through 8 as you read the following description.

SKULL The skull is composed of two regions: the cranium, consisting of the bones that enclose the brain and ear, and the facial region, consisting of the bones that support the nose, eyes, and mouth. Look into the external nares and observe the intricately folded nasal conchae, which support the olfactory epithelium.

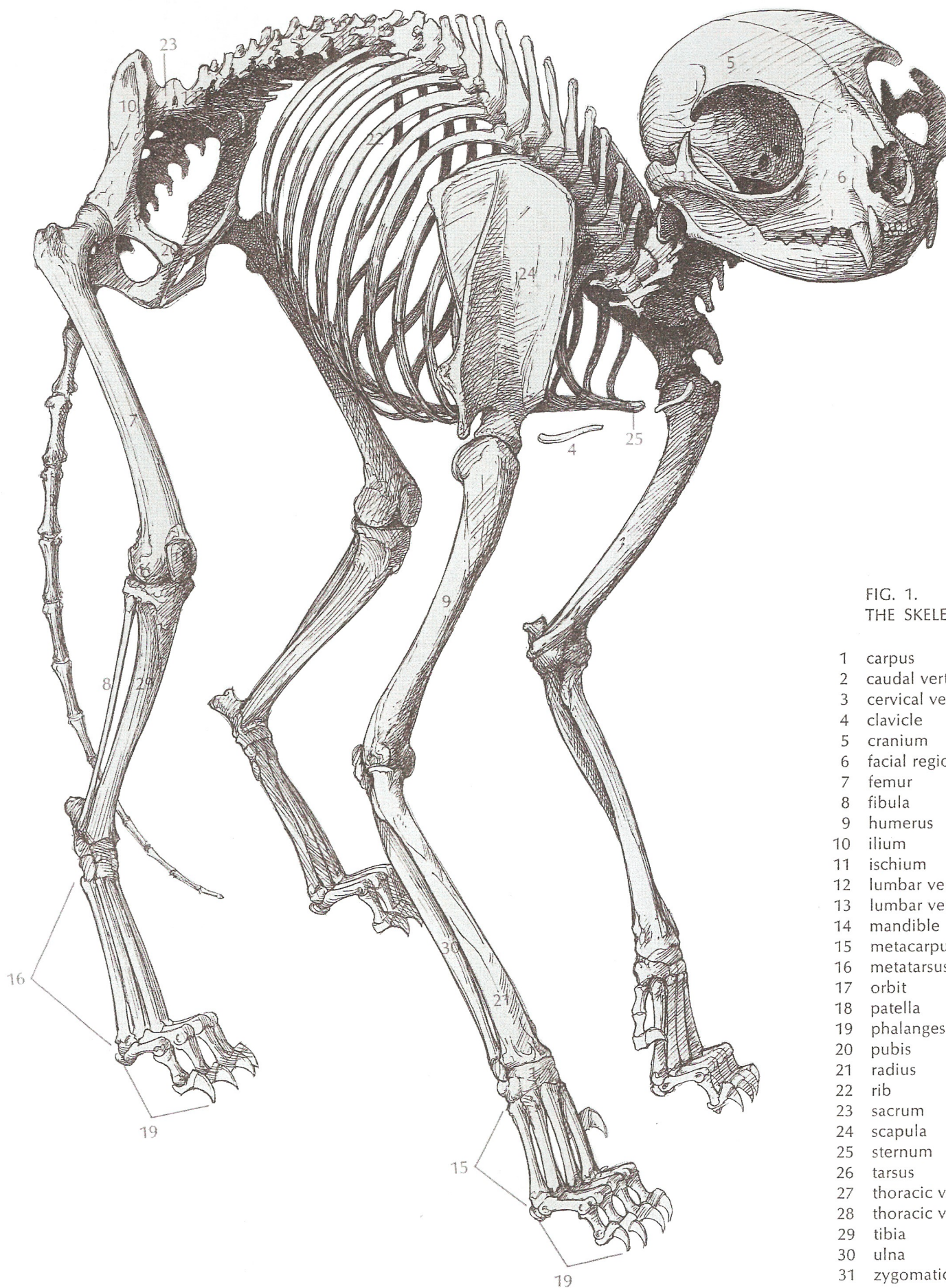
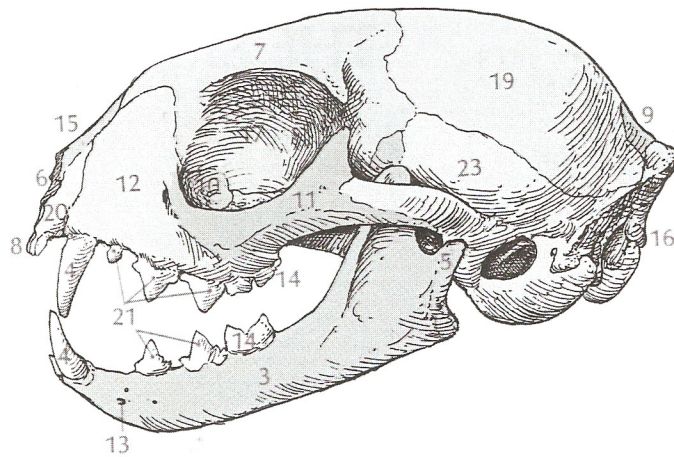


FIG. 1.
THE SKELETON

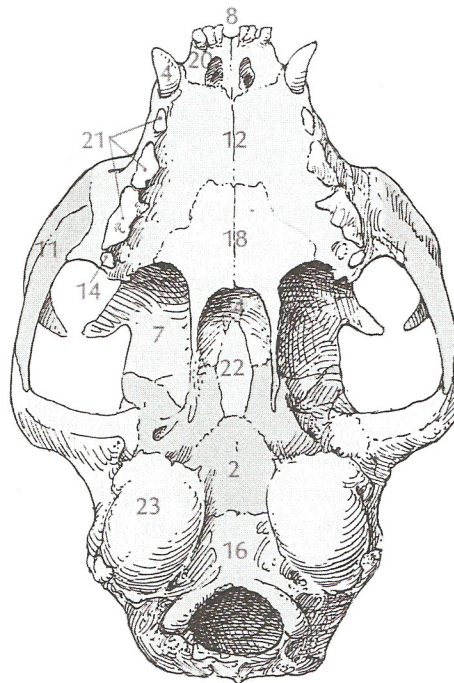
- 1 carpus
- 2 caudal vertebra
- 3 cervical vertebra (7)
- 4 clavicle
- 5 cranium
- 6 facial region
- 7 femur
- 8 fibula
- 9 humerus
- 10 ilium
- 11 ischium
- 12 lumbar vertebra (1)
- 13 lumbar vertebra (7)
- 14 mandible
- 15 metacarpus
- 16 metatarsus
- 17 orbit
- 18 patella
- 19 phalanges
- 20 pubis
- 21 radius
- 22 rib
- 23 sacrum
- 24 scapula
- 25 sternum
- 26 tarsus
- 27 thoracic vertebra (1)
- 28 thoracic vertebra (13)
- 29 tibia
- 30 ulna
- 31 zygomatic arch

FIG. 2.
THE SKULL

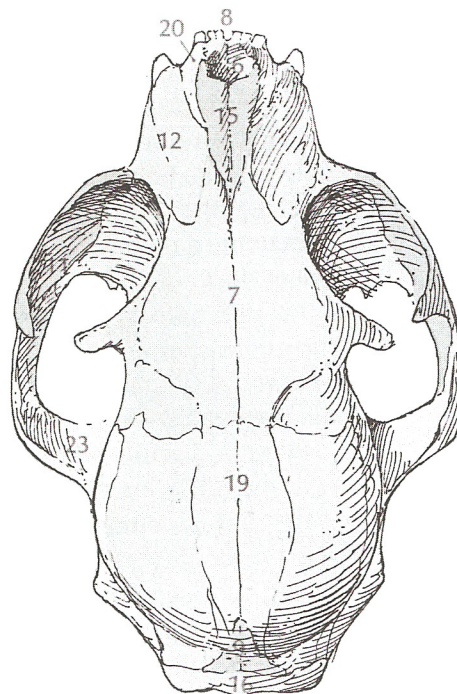
- 1 angular process of dentary bone
- 2 basisphenoid bone
- 3 body of dentary bone
- 4 canine tooth
- 5 condyloid process of dentary bone
- 6 external nares
- 7 frontal bone
- 8 incisor teeth
- 9 interparietal bone
- 10 lacrimal bone
- 11 malar bone
- 12 maxilla
- 13 mental foramen
- 14 molar tooth
- 15 nasal bone
- 16 occipital bone
- 17 orbit
- 18 palatine bone
- 19 parietal bone
- 20 premaxilla
- 21 premolar teeth
- 22 presphenoid bone
- 23 temporal bone
- 24 vomer



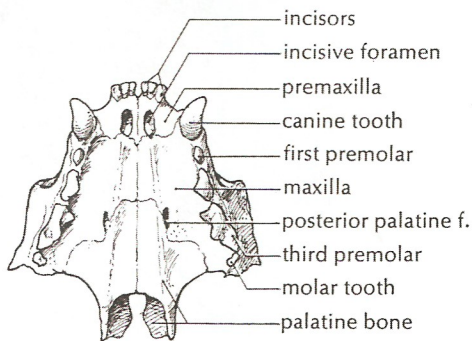
lateral view



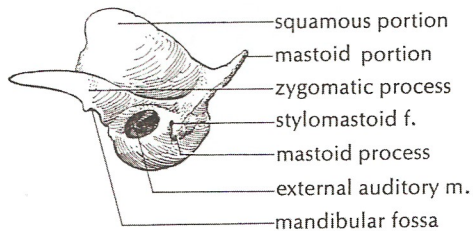
ventral view



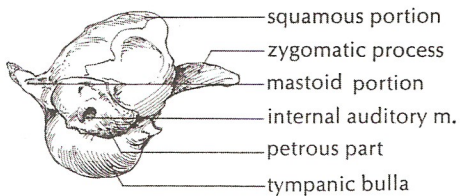
dorsal view



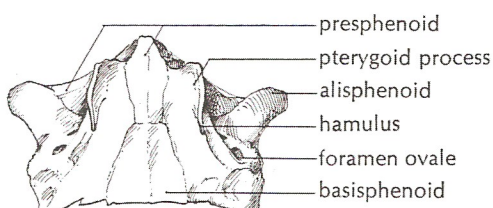
hard palate, ventral view



left temporal bone, lateral view



left temporal bone, medial view



presphenoid and basisphenoid bones, ventral view

The bony socket enclosing the eye is termed the orbit. Below the orbit is the zygomatic arch composed of the malar bone, the zygomatic process of the maxilla, and the zygomatic process of the temporal bone. On the inferior surface of the zygomatic process of the temporal bone find the mandibular fossa, a depression for the articulation of the condyloid process of the dentary bone. The two dentary bones are fused in front by the mandibular symphysis: together they constitute the mandible. Posterior to the orbit, and separated from it by the postorbital processes, is the temporal fossa, which is filled in life by the temporal muscle.

Observe the hard palate, a bony partition that separates the nasal cavity from the mouth. It is formed by portions of the palatine, maxilla, and premaxilla. At the posterior end of the hard palate are the internal nares, through which air passes from the nasal cavities to the pharynx.

Look into the foramen magnum and observe the cribriform plate of the ethmoid bone at the anterior end of the cranial cavity. Olfactory nerves pass from the olfactory bulbs through the numerous small holes in the cribriform plate to reach the olfactory epithelium of the nasal cavity.

Look into the external auditory meatus to see the cavity of the middle ear. In life the external auditory meatus is closed by the tympanic membrane. Pass a small wire into the canal for the Eustachian tube to establish the connection between this canal and the middle ear cavity. In most specimens the delicate auditory ossicles may be seen within the middle ear cavity, and the round window will be seen at the posterior end of the cavity (see Fig. 75 on p. 107).

Trace the sutures of the skull and establish the contour of each bone. Also study a disarticulated skull to form an understanding of the shapes of the bones and their relationships.

The temporal bone represents the fusion of several elements that are separate in lower vertebrates. The squamous part of the temporal bone forms the zygomatic process and part of the lateral wall of the cranium. The tympanic part forms the tympanic bulla and the walls of the cavity of the middle ear. The petromastoid portion of the temporal bone consists of two parts: the mastoid process, visible in the lateral view of the skull, and the petrous part, visible in the sagittal section. The petrous part contains the inner ear.

The interparietal bone fuses with the occipitals and parietals in mature individuals and can be observed best in the skull of a young cat.

The sphenoid bone consists of three parts: a central basisphenoid and two lateral alisphenoids. The pterygoid processes, which lie on either side of the presphenoid bone, are also parts of the basisphenoid. The presphenoid, a separate bone which may be seen in the inferior view and in the lateral view, forms part of the medial wall of the orbit.

Look into the internal nares and observe that the vomer extends dorsally in the midline to form part of the partition between the two sides of the nasal cavity.

Examine the two halves of a sagittally sectioned skull to see the perpendicular plate of the ethmoid, a thin bony partition

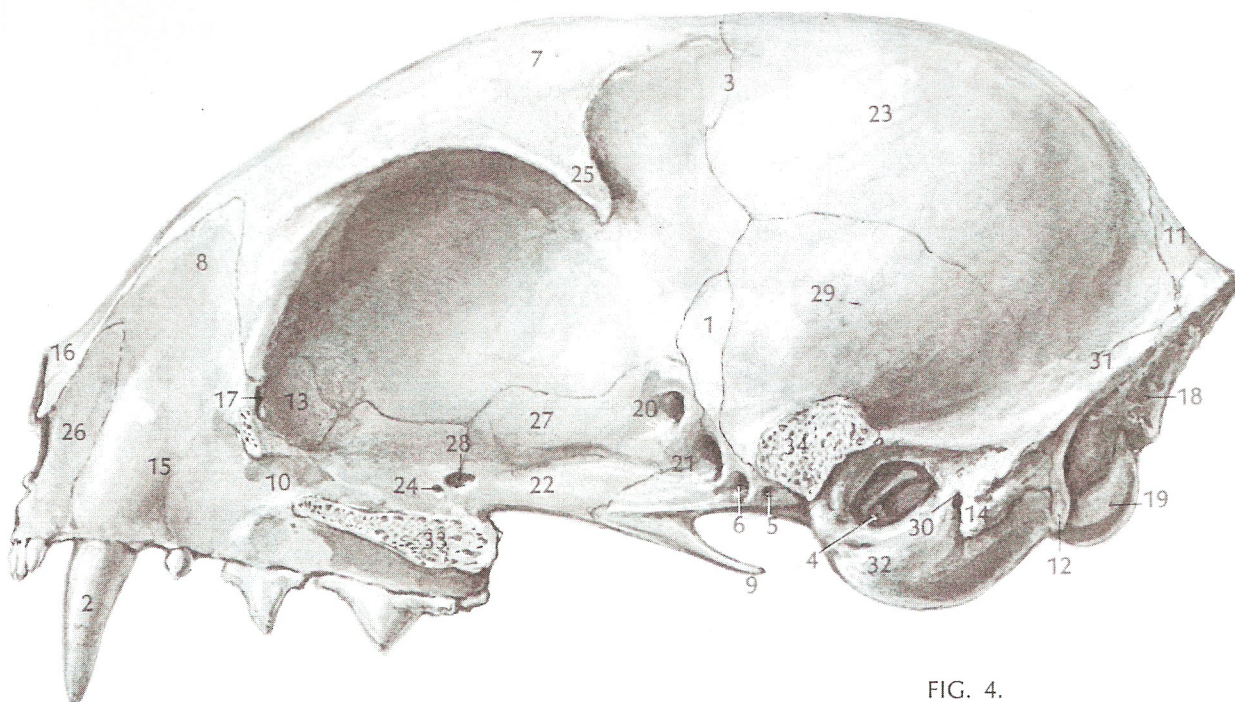


FIG. 4.
THE SKULL, LATERAL VIEW

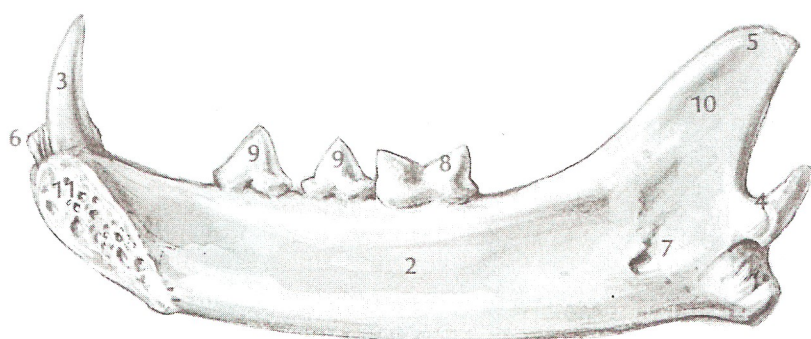


FIG. 3.
THE DENTARY BONE, MEDIAL VIEW

- 1 angular process
- 2 body
- 3 canine tooth
- 4 condyloid process
- 5 coronoid process
- 6 incisors
- 7 mandibular foramen
- 8 molar tooth
- 9 premolar teeth
- 10 ramus
- 11 symphysis

- 1 alisphenoid
- 2 canine tooth
- 3 coronal suture
- 4 external auditory meatus
- 5 foramen ovale
- 6 foramen rotundum
- 7 frontal bone
- 8 frontal process of maxilla
- 9 hamulus of pterygoid process
- 10 infraorbital foramen
- 11 interparietal bone
- 12 jugular process of occipital bone
- 13 lacrimal bone
- 14 mastoid process
- 15 maxilla
- 16 nasal bone
- 17 nasolacrimal canal
- 18 occipital bone
- 19 occipital condyle
- 20 optic foramen
- 21 orbital fissure
- 22 palatine bone
- 23 parietal bone
- 24 posterior palatine canal
- 25 postorbital process
- 26 premaxilla
- 27 presphenoid bone
- 28 sphenopalatine foramen
- 29 squamous portion of temporal bone
- 30 stylomastoid foramen
- 31 superior nuchal line
- 32 tympanic bulla
- 33 zygomatic process of maxilla
- 34 zygomatic process of temporal bone

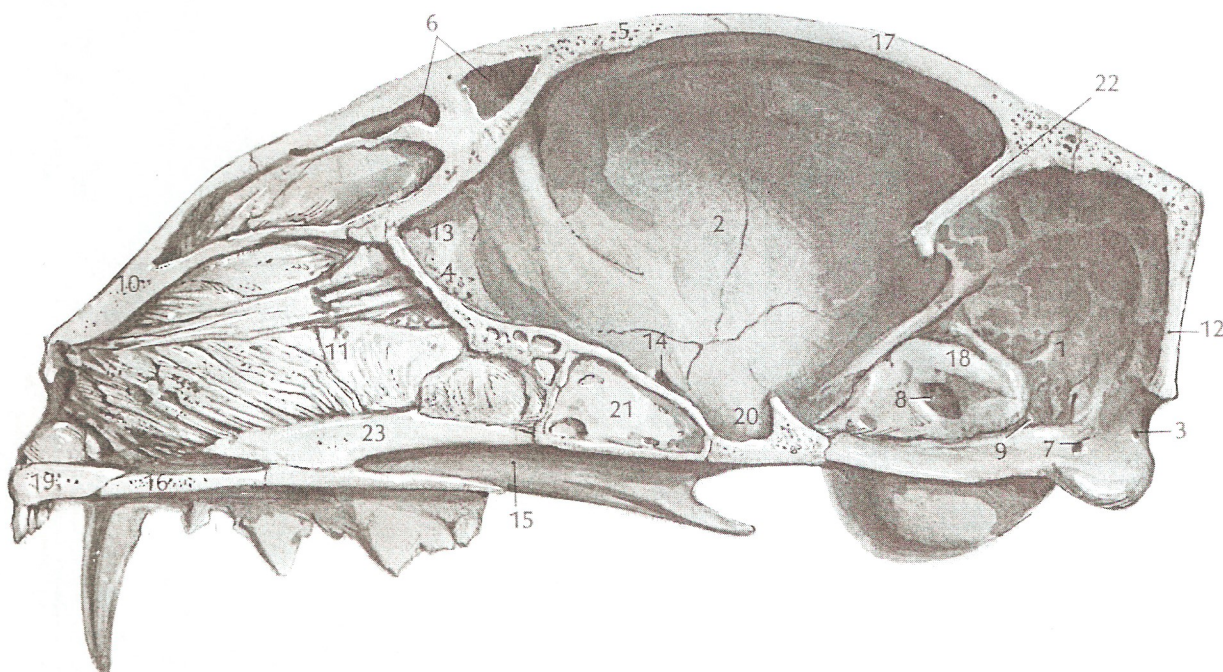


FIG. 5.
SAGITTAL SECTION OF THE SKULL

- | | | |
|-------------------------------|------------------------|------------------------|
| 1 cerebellar fossa | 10 nasal bone | 18 petrous part of |
| 2 cerebral fossa | 11 nasal conchae | petromastoid |
| 3 condyloid canal | 12 occipital bone | 19 premaxilla |
| 4 cribriform plate of ethmoid | 13 olfactory fossa | 20 sella turcica of |
| 5 frontal bone | 14 optic foramen | basisphenoid |
| 6 frontal sinuses | 15 palatine bone | 21 sphenoidal sinus of |
| 7 hypoglossal foramen | 16 palatine process of | presphenoid |
| 8 internal auditory meatus | maxilla | 22 tentorium |
| 9 jugular foramen | 17 parietal bone | 23 vomer |

that lies in the median sagittal plane and divides the nasal cavity into two equal parts. In life this bony partition is continued anteriorly by a cartilaginous partition.

The ethmoid bone consists of the cribriform plate, the perpendicular plate, and the posterior nasal conchae. Other areas of the nasal conchae constitute portions of the maxilla and the nasal bone.

After memorizing the names of the bones, study the foramina and other structures illustrated in Figures 4, 5, 6, and 7.

Examine the sagittal section of the skull and determine the internal and external opening of each foramen by passing a thin wire through it. As you do this you will find it helpful to review the cranial nerves and to associate them with the foramina through which they pass (see Figure 8 and Figure 64, p. 87).

The hyoid bone is a delicate structure which lies at the anterior end of the larynx and gives attachment to certain muscles of the tongue and larynx. It consists of a short body, to which are attached anterior and posterior horns. The anterior horn has four articulated sections; the terminal section is attached to the tympanic bulla. The posterior horn is a single section attached to the larynx.

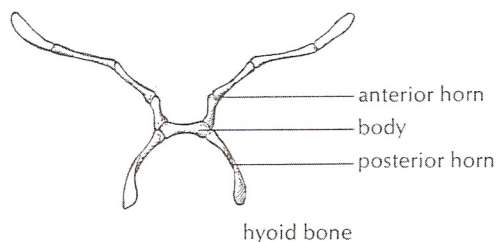
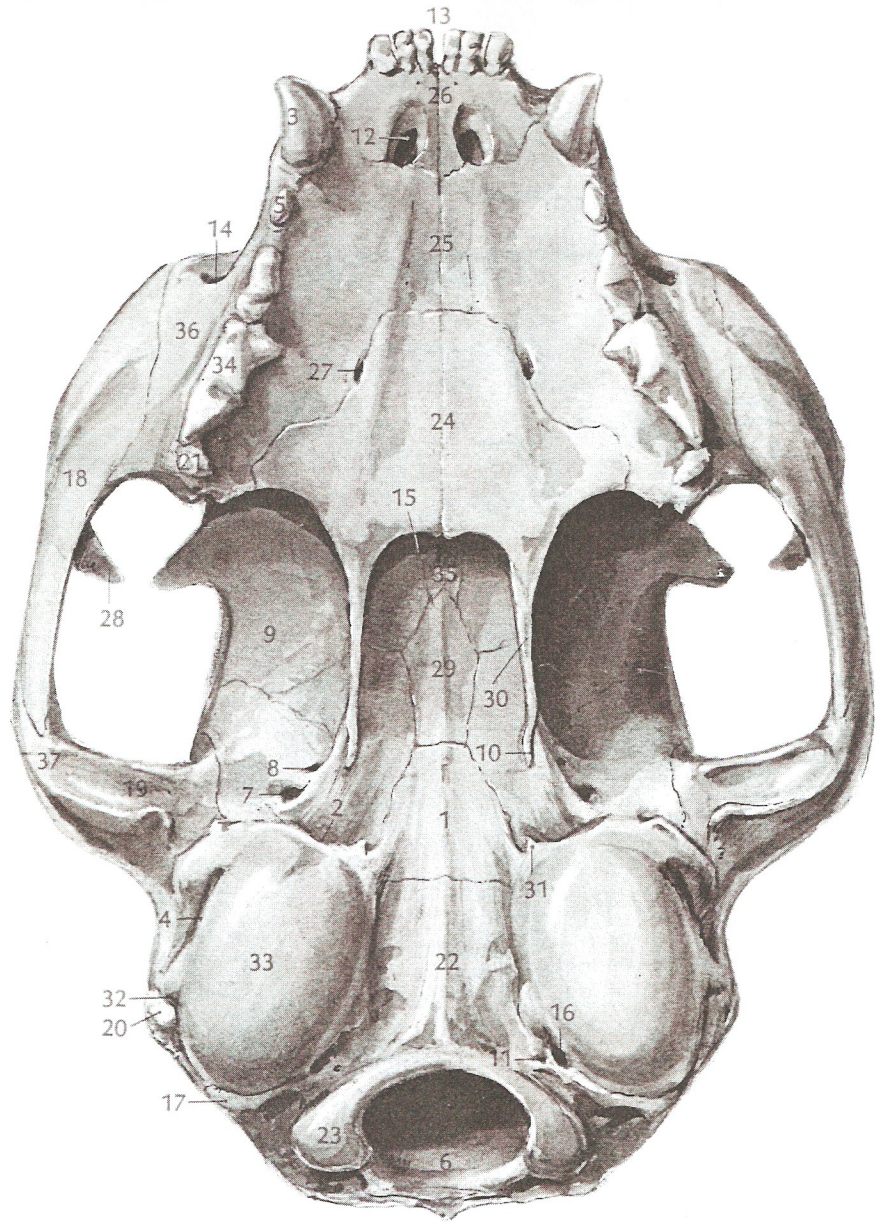


FIG. 6.
THE SKULL, VENTRAL VIEW

- 1 basisphenoid bone
- 2 canal for Eustachian tube
- 3 canine tooth
- 4 external auditory meatus
- 5 first premolar
- 6 foramen magnum
- 7 foramen ovale
- 8 foramen rotundum
- 9 frontal bone
- 10 hamulus of pterygoid process
- 11 hypoglossal foramen
- 12 incisive foramen
- 13 incisors
- 14 infraorbital foramen
- 15 internal nares
- 16 jugular foramen
- 17 jugular process
- 18 malar bone
- 19 mandibular fossa
- 20 mastoid process of temporal bone
- 21 molar tooth
- 22 occipital bone
- 23 occipital condyle
- 24 palatine bone
- 25 palatine process of maxilla
- 26 palatine process of premaxilla
- 27 posterior palatine foramen
- 28 postorbital process of malar
- 29 presphenoid bone
- 30 pterygoid process of basisphenoid
- 31 styliiform process
- 32 stylomastoid foramen
- 33 tympanic bulla
- 34 third premolar
- 35 vomer
- 36 zygomatic process of maxilla
- 37 zygomatic process of temporal



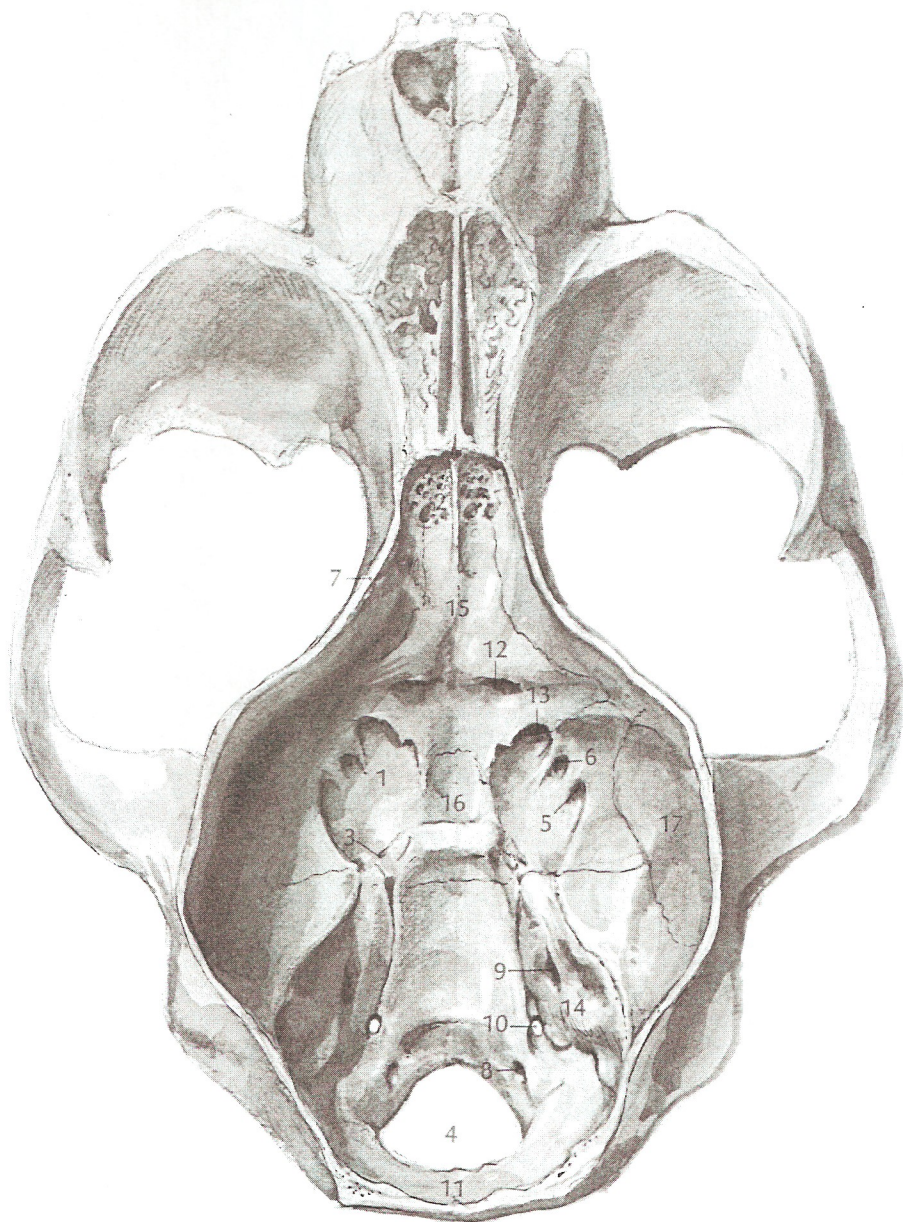


FIG. 7.
THE FLOOR OF THE CRANIAL CAVITY

- 1 basisphenoid
- 2 cribriform plate of ethmoid
- 3 foramen lacerum
- 4 foramen magnum
- 5 foramen ovale
- 6 foramen rotundum
- 7 frontal bone
- 8 hypoglossal foramen
- 9 internal auditory meatus
- 10 jugular foramen
- 11 occipital bone
- 12 optic foramen
- 13 orbital fissure
- 14 petrous part of petromastoid
- 15 presphenoid
- 16 sella turcica
- 17 temporal bone

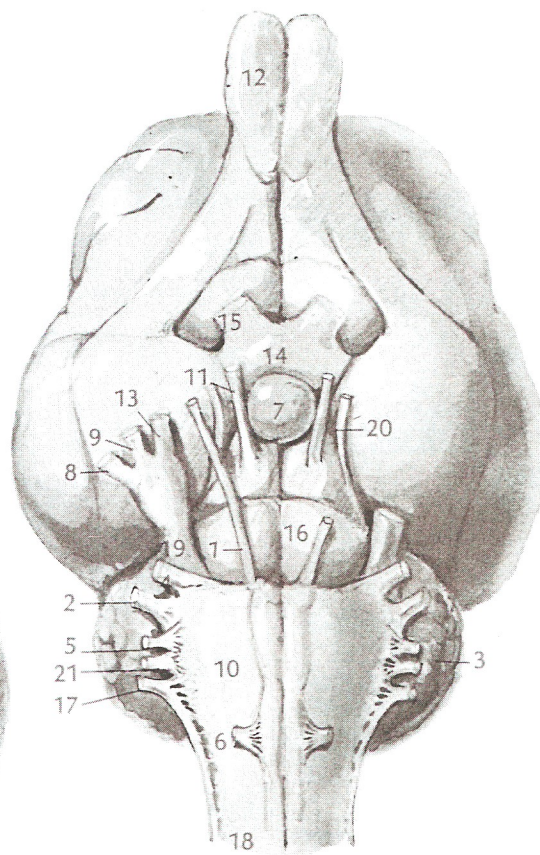


FIG. 8.
VENTRAL VIEW OF THE BRAIN

- 1 abducens nerve (6)
- 2 auditory nerve (8)
- 3 cerebellum
- 4 facial nerve (7)
- 5 glossopharyngeal nerve (9)
- 6 hypoglossal nerve (12)
- 7 hypophysis
- 8 mandibular branch of trigeminal
- 9 maxillary branch of trigeminal
- 10 medulla oblongata
- 11 oculomotor nerve (3)
- 12 olfactory nerve (1)
- 13 ophthalmic branch of trigeminal
- 14 optic chiasm
- 15 optic nerve
- 16 pons
- 17 spinal accessory nerve (11)
- 18 spinal cord
- 19 trigeminal nerve (5)
- 20 trochlear nerve (4)
- 21 vagus nerve (10)

VERTEBRAL COLUMN

The vertebral column consists of five regions: cervical (seven vertebrae), thoracic (thirteen vertebrae), lumbar (seven vertebrae), sacral (three vertebrae), and caudal (about twenty vertebrae). In life the vertebrae are connected by flattened disks of fibrocartilage, strong ligaments, and complex muscles.

Examine a set of disarticulated vertebrae and learn to identify a vertebra selected at random as cervical, thoracic, lumbar, sacral, or caudal. Referring to a mounted skeleton, arrange the vertebrae in order and identify the parts labeled in Figure 9. Fit the skull against the atlas to see the articulation of the occipital condyles with the anterior articular processes (prezygapophyses) of the atlas. The atlas is atypical in that it has no body and no spinous process. Each wing of the atlas is perforated by a vertebralarterial canal through which the vertebral artery passes. This canal is found in the first six cervical vertebrae. In the atlas there is also a small atlantal foramen just above the anterior articular process for the passage of the first cervical nerve.

The odontoid process (peculiar to the axis) represents the body of the atlas, which fuses with the axis.

Put several cervical vertebrae together and observe the manner in which the articular facets fit each other. Compare the relative size of the body and the vertebral arch in a typical cervical vertebra with the bodies and the vertebral arches of typical

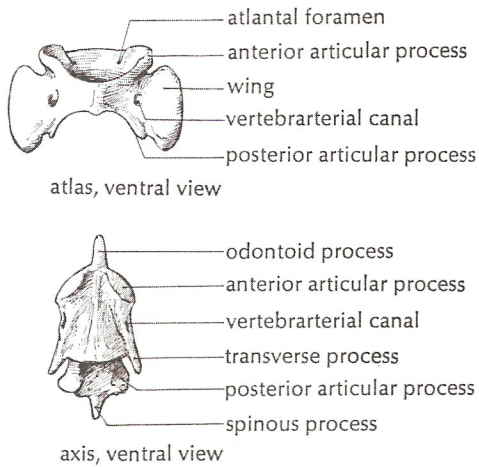
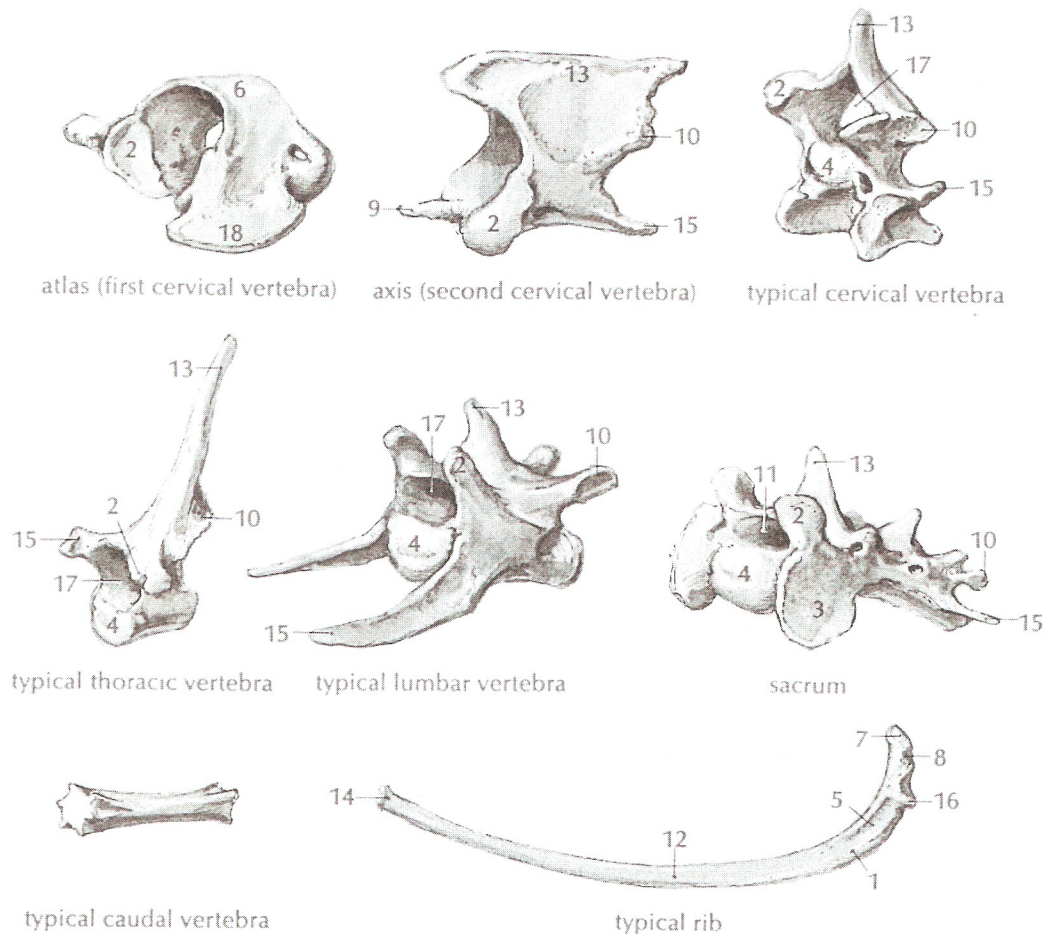
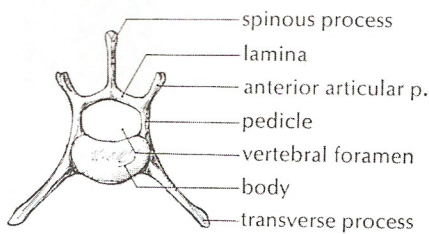


FIG. 9.

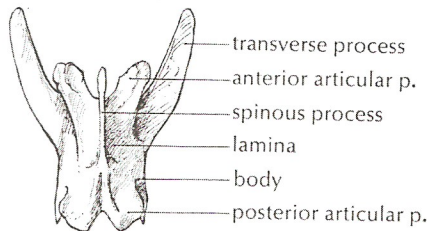
TYPICAL VERTEBRAE AND RIB



- 1 angle
- 2 anterior articular process (prezygapophysis)
- 3 articular surface
- 4 body
- 5 costal groove
- 6 dorsal arch
- 7 head
- 8 neck
- 9 odontoid process
- 10 posterior articular process (postzygapophysis)
- 11 sacral canal
- 12 shaft
- 13 spinous process
- 14 sternal end
- 15 transverse process
- 16 tubercle
- 17 vertebral foramen
- 18 wing



lumbar vertebra, anterior view



lumbar vertebra, dorsal view

APPENDICULAR SKELETON

FEMUR

thoracic and lumbar vertebrae. Also compare the shapes and positions of the articular facets in the cervical, thoracic, and lumbar vertebrae. Interpret the observed differences in terms of the structural requirements and the kinds of movement permitted in the various parts of the vertebral column.

Comparing the disarticulated vertebrae with the articulated skeleton, fit two thoracic vertebrae together with a rib. Observe that the head of the rib articulates with facets on both vertebral bodies and that the tubercle of the rib fits into an articular facet on the transverse process of the more caudal of the two vertebrae. The last three thoracic vertebrae have but one articular facet, located toward the anterior part of the body. Ventrally, ribs 1-9 are attached to the sternum by costal cartilages. Ribs 10, 11, and 12 are attached to the ninth costal cartilage, and rib 13 is unattached.

Examine the sternum in the articulated skeleton. It consists of eight separate units termed sternebrae. The first sternebra is the manubrium; the six central sternebrae constitute the body of the sternum; the terminal sternebra is the xiphisternum.

Place several lumbar vertebrae together and observe the form of the articular facets. Between each pair of vertebral bodies observe the paired openings, intervertebral foramina, through which the spinal nerves exit from the vertebral canal. Intervertebral foramina are found between every pair of vertebrae from the first and second cervical through the eighth and ninth caudal.

The sacrum consists of three vertebrae fused together. Observe the similarity between the last sacral vertebra and the first caudal vertebra. Note that the neural arches, transverse processes, and articular processes undergo progressive degeneration in the tail.

Study the bones of the forelimbs and hindlimbs as seen in the articulated skeleton. Select the scapulae, innominate bones, and long bones of the limbs from your set of disarticulated bones. Comparing the separate bones with the articulated skeleton, learn to distinguish the bones of the right side from those of the left. Fit the disarticulated bones together and observe the forms of the articular surfaces. You should be able to identify the articular surfaces of each bone and to match these surfaces with the corresponding articular surfaces of the bones with which it is associated.

Examine the femur. On the posterior side near the proximal and distal articular surfaces find the nutrient foramina, which admit vessels and nerves to the medullary cavity. Similar foramina will be found in many other bones. If your skeleton was made from a relatively young animal, you will see epiphyseal lines between the ends of the femur and the shaft. Similar lines may be seen in other long bones. The epiphyseal lines represent the junction between the centers of ossification in the ends (epiphyses) and the shaft (diaphysis) of the bone.

Identify and memorize the parts of the bones by referring to Figures 10, 11, 12, and 13.

The difficulty of identifying the disarticulated bones of the tarsus and carpus is too great to justify spending the required time, and you should therefore identify the bones of the feet as articulated units.

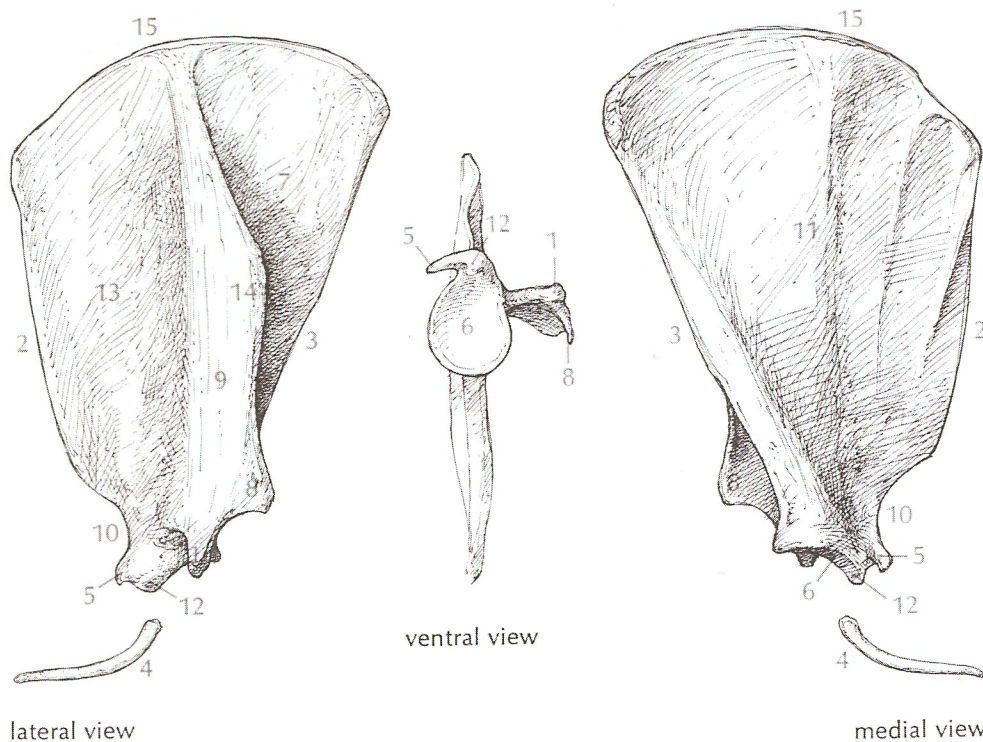


FIG. 10A.
THE LEFT SCAPULA
AND CLAVICLE

- 1 acromion
- 2 anterior border
- 3 axillary border
- 4 clavicle
- 5 coracoid process
- 6 glenoid fossa
- 7 infraspinous fossa
- 8 metacromion
- 9 spine
- 10 scapular notch
- 11 subscapular fossa
- 12 supraglenoid tubercle
- 13 supraspinous fossa
- 14 tuberosity of spine
- 15 vertebral border

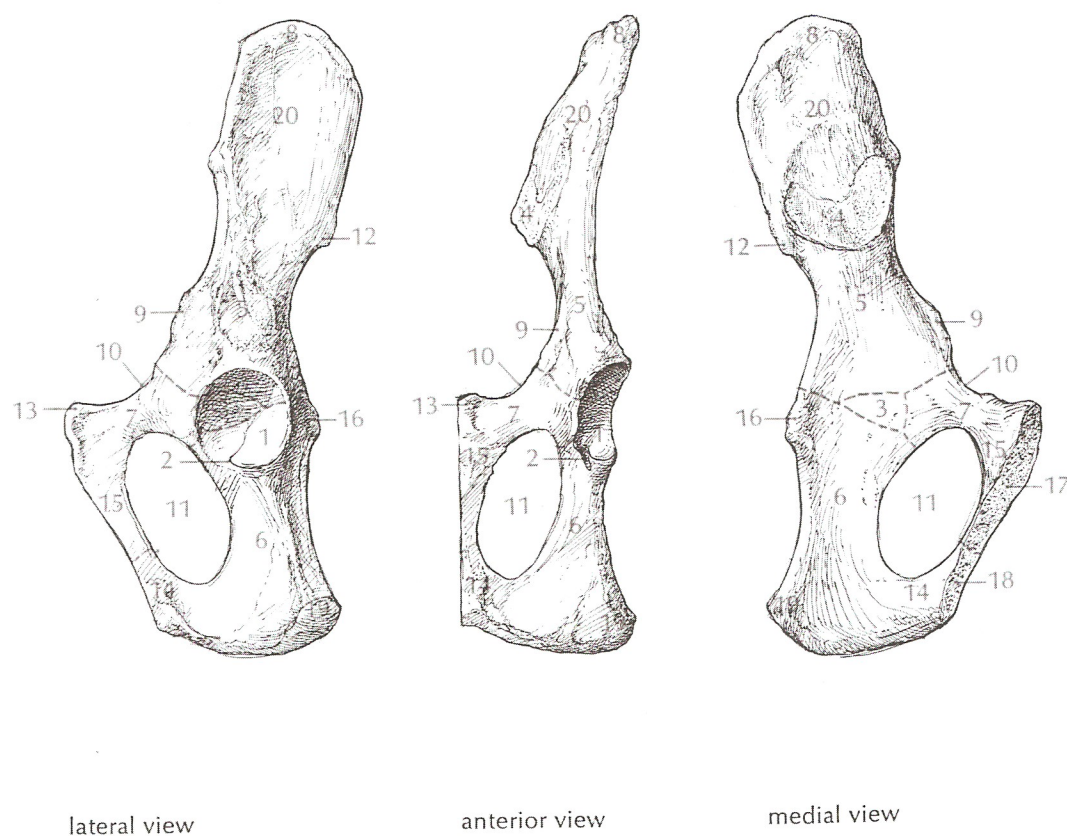


FIG. 10B.
THE LEFT
INNOMINATE BONE

- 1 acetabulum
- 2 acetabular notch
- 3 acetabular bone
- 4 auricular impression
- 5 body of ilium
- 6 body of ischium
- 7 body of pubis
- 8 crest of ilium
- 9 iliopectineal eminence
- 10 iliopectineal line
- 11 obturator foramen
- 12 post. inferior spine
- 13 pubic tubercle
- 14 ramus of ischium
- 15 ramus of pubis
- 16 spine of ischium
- 17 symphysis pubis
- 18 symphysis ischii
- 19 tuberosity of ischium
- 20 wing of ilium

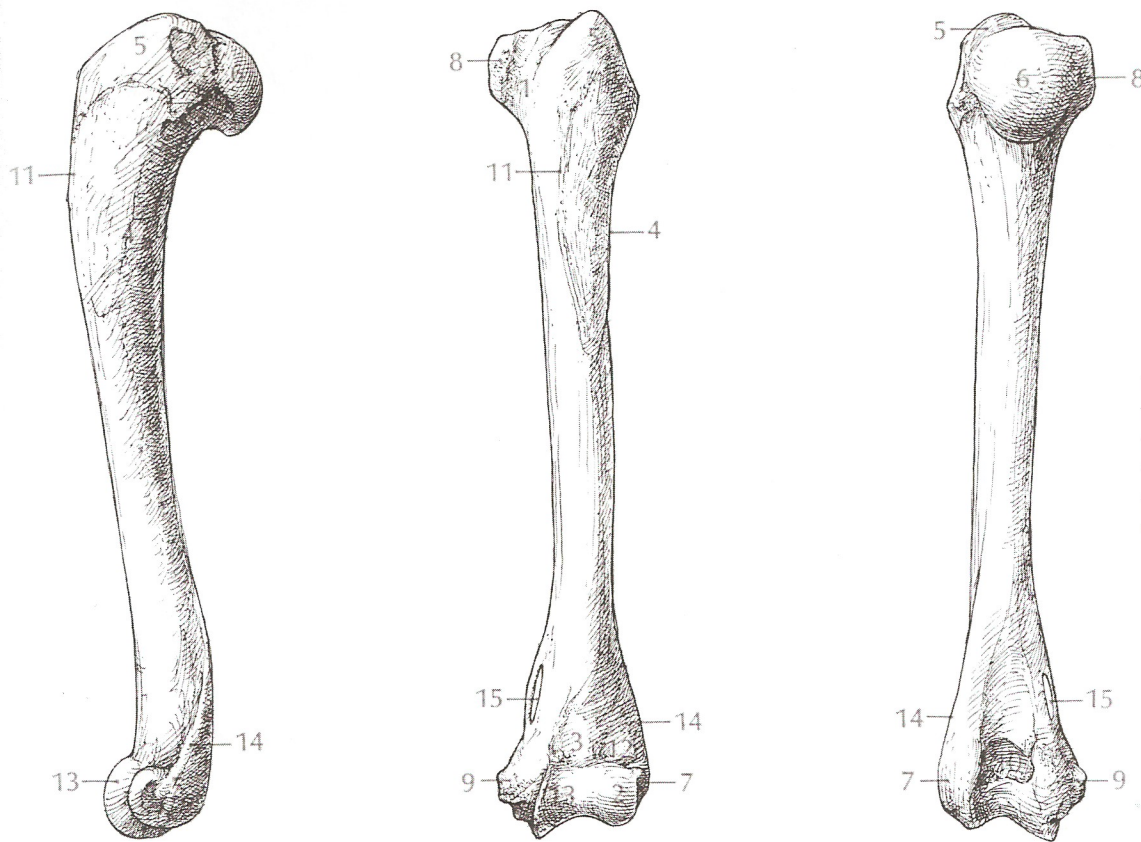


FIG. 11A.
THE LEFT HUMERUS

- 1 bicipital groove
- 2 capitulum
- 3 coronoid fossa
- 4 deltoid ridge
- 5 greater tuberosity
- 6 head
- 7 lateral epicondyle
- 8 lesser tuberosity
- 9 medial epicondyle
- 10 olecranon fossa
- 11 pectoral ridge
- 12 radial fossa
- 13 trochlea
- 14 supracondyloid ridge
- 15 supracondyloid foramen

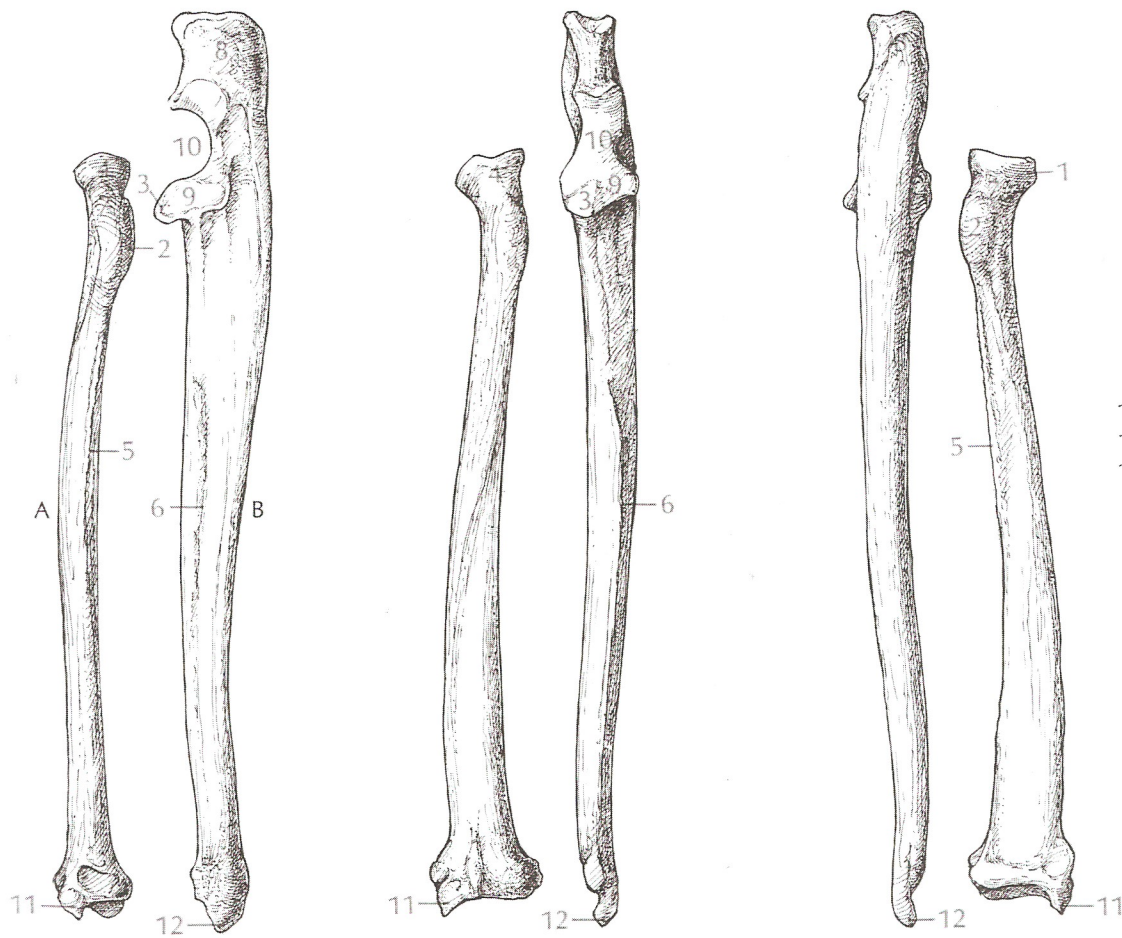


FIG. 11B.
THE LEFT RADIUS
AND ULNA

- 1 articular circumference
- 2 bicipital tuberosity
- 3 coronoid process
- 4 head
- 5 interosseous crest of radius
- 6 interosseous crest of ulna
- 7 neck
- 8 olecranon
- 9 radial notch
- 10 semilunar notch
- 11 styloid process of radius
- 12 styloid process of ulna
- A radius
- B ulna

lateral view

anterior view

posterior view

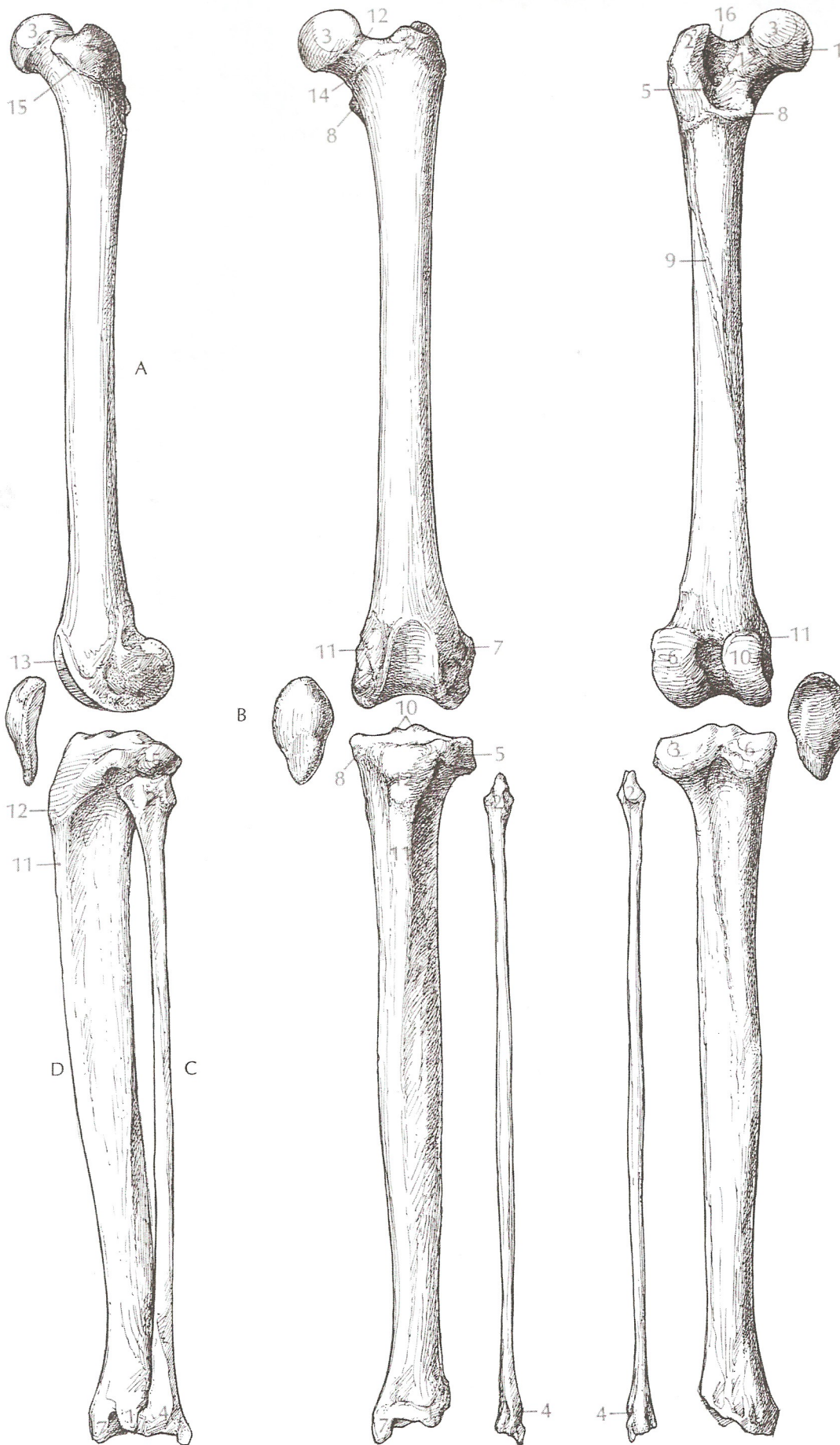


FIG. 12A.
THE LEFT FEMUR
AND PATELLA

- 1 fovea capitis
- 2 greater trochanter
- 3 head
- 4 intercondyloid fossa
- 5 intertrochanteric line
- 6 lateral condyle
- 7 lateral epicondyle
- 8 lesser trochanter
- 9 linea aspera
- 10 medial condyle
- 11 medial epicondyle
- 12 neck
- 13 patellar surface
- 14 spiral ridge
- 15 transverse line
- 16 trochanteric fossa
- A femur
- B patella

FIG. 12B.
THE LEFT TIBIA
AND FIBULA

- 1 dorsal projection
- 2 head
- 3 lateral condyle
- 4 lateral malleolus
- 5 lateral tuberosity
- 6 medial condyle
- 7 medial malleolus
- 8 medial tuberosity
- 9 popliteal notch
- 10 spine
- 11 tibial crest
- 12 tibial tuberosity
- C fibula
- D tibia

lateral view

anterior view

posterior view

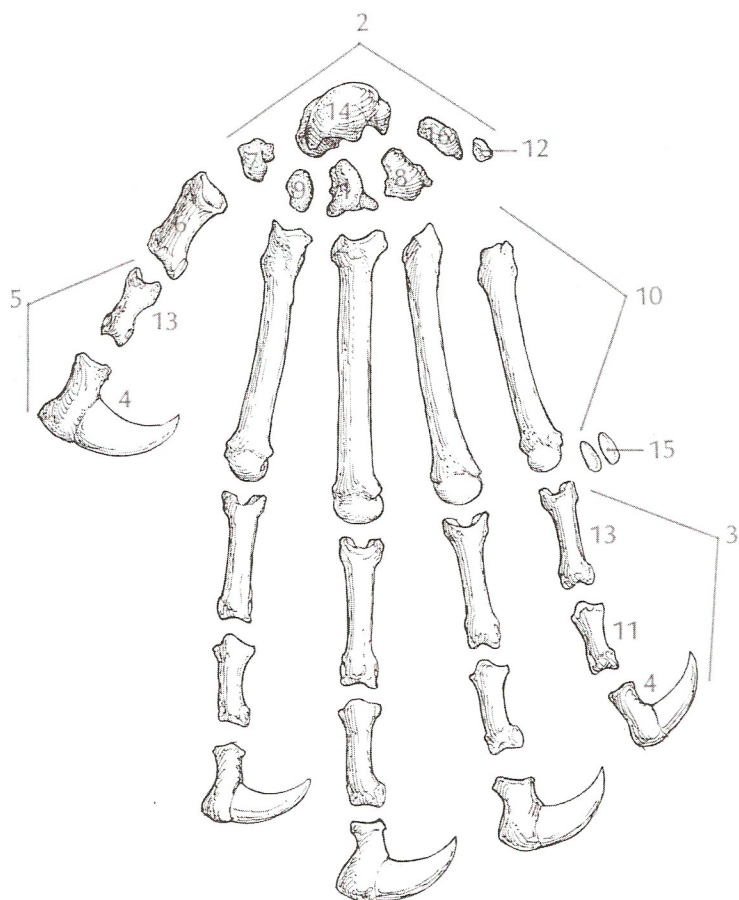


FIG. 13A.
BONES OF THE LEFT
FOREFOOT, DORSAL VIEW

- 1 capitate
- 2 carpals
- 3 digits
- 4 distal phalanx
- 5 first digit
- 6 first metacarpal
- 7 greater multangular
- 8 hamate
- 9 lesser multangular
- 10 metacarpals
- 11 middle phalanx
- 12 pisiform
- 13 proximal phalanx
- 14 scapholunar
- 15 sesamoid
- 16 triquetral

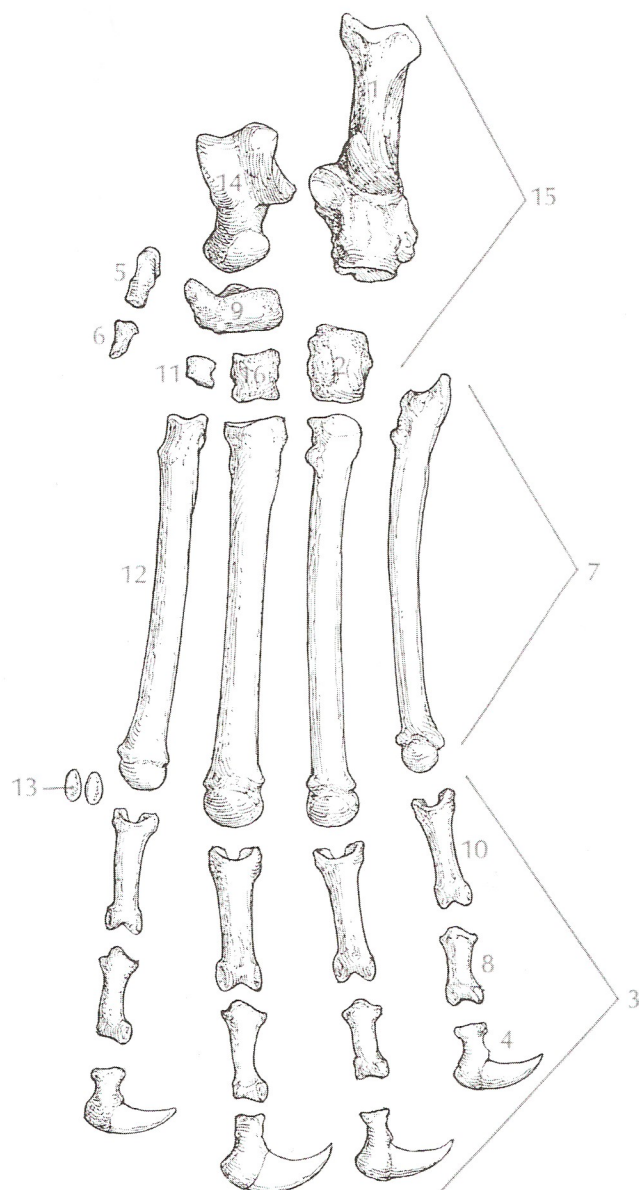


FIG. 13B.
BONES OF THE LEFT
HINDFOOT, DORSAL VIEW

- 1 calcaneus
- 2 cuboid
- 3 digits
- 4 distal phalanx
- 5 first cuneiform
- 6 first metatarsal
- 7 metatarsals
- 8 middle phalanx
- 9 navicular
- 10 proximal phalanx
- 11 second cuneiform
- 12 second metatarsal
- 13 sesamoid
- 14 talus
- 15 tarsals
- 16 third cuneiform