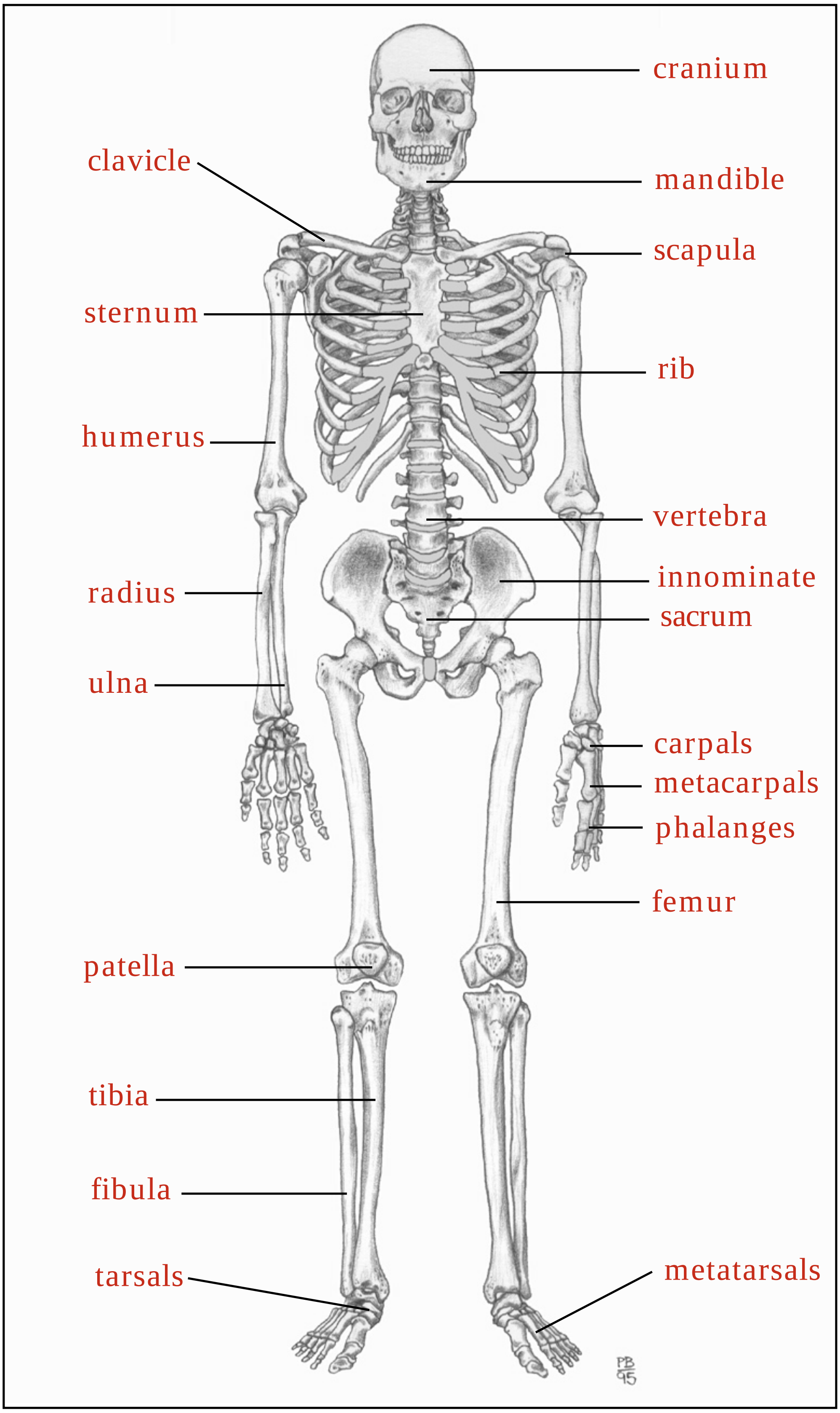
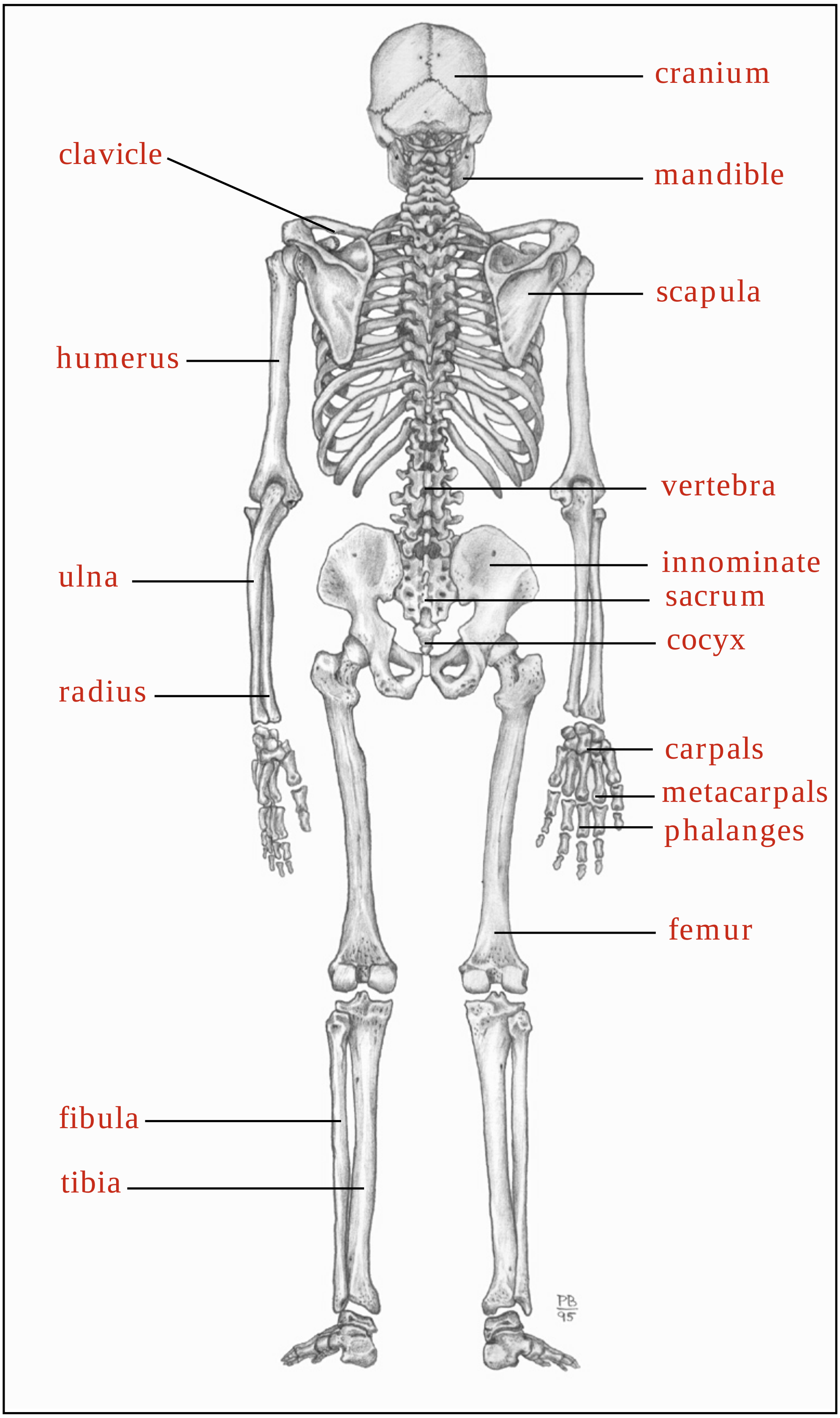
The human skeleton
anterior view



The human skeleton
posterior view



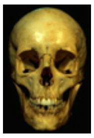
The human skeleton

The adult human skeleton contains 206 bones which vary in size from the almost microscopic ossicles of the inner ear to femora which may exceed 450 mm in length. This great variation in size is accompanied by similar variation in shape which makes identification of individual bones relatively straightforward. Some bones, however, are more difficult to identify than others, with the bones of the hands, feet, rib cage and vertebral column requiring closer scrutiny than the rest. This is true both within our species and between our species and other mammals. While it is very difficult to confuse a human femur with that from a large kangaroo, phalanges, metatarsals and metacarpals require greater expertise. Prior to epiphyseal union infant and juvenile skeletal elements may also prove problematic. This is particulary true where the infant bones are fragmentary and missing their articular surfaces. In part this is a reflection of experience as osteological collections contain relatively few subadult skeletons and they are less frequently encountered in forensic and anthropological investigations.

There are a number of excellent texts on human osteology and several of the more general texts on physical anthropology have a chapter devoted to the human skeleton and dentition. Reference books on human anatomy, for instance Warwick and Williams's (1973) "Gray's Anatomy", and dental anatomy, for example Wheeler (1974), are a good source of information although often aimed at a specialist audience. Donald Brothwell's "Digging up Bones" has a broad coverage of the archaeological and anthropological aspects of excavating and interpreting human skeletal materials and is an excellent introductory text. More detailed books on human skeletal anatomy, with an anthropological orientation, are provided by Shipman et al. (1985) and White (1991). For an evolutionary perspective Aiello and Dean's (1990) "Introduction to human evolutionary anatomy" is the most stimulating and thorough text available. For those of you who wish to distinguish human bones from those of other Australian mammals Merrilees and Porter (1979) provide a useful guide to the identification of some Australian mammals. At present there are no publications directly comparing human skeletons with those from the native and introduced mammals found in Australia.

The short skeletal atlas which follows should enable students without access to texts in anatomy or skeletal materials to gain some familiarity with the bones of the human skeleton. I have concentrated on illustrations, brief descriptions and references to major sources of forensic literature. Where data is available there are summary statistics, means and standard deviations, for the dimensions of the relevant skeletal element in male and female prehistoric Aborigines. The skeletons which provided these data were not of known sex and sex was determined through examination of the associated pelvis. Data on other human populations can be obtained by following up the references listed in your unit booklet.

The cranium

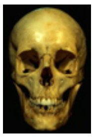




The human cranium consists of a large globular vessel which protects the brain, as well as providing support for masticatory and nuchal muscles, and an orofacial skeleton for food processing and the support of sensory systems. Excluding the mandible and hyoid the cranium is normally made up of 27 bones which interlock at sutures. The majority of these bones are paired, however, the frontal, occipital, sphenoid, ethmoid and vomer bones are single. At birth a number of the cranial bones are incomplete as parts of the chondrocranium remain unossified. For instance the occipital bone is divided in four and the frontal bone divided sagitally. During the first 24 months of life fibrous tissue membranes called fontanelles ossify and the individual cranial bones become complete. By the second year of life the bones of the cranial vault have interlocked at the sutures. Growth in the neurocranium continues until approximately 15 years. Growth of the facial skeleton, however, may continue until 25 years due to the effects of delayed tooth eruption and growth of the nasopharynx. In later adult life the bones in the cranial vault continue to thicken and the sutures may become obliterated.

Far more has been written about the cranium than all of the other bones in the skeleton combined. Most text books on anatomy have large sections devoted to the cranium, for instance Warwick and Williams (1973), and there are books in which the evolution, anatomy, physiology, growth and development of the cranium form the primary subject matter (Hanken and Hall 1993). The cranium is also an important source of information in forensic and anthropological investigations. There is an extensive literature on sex determination of adult human crania using both morphological and metrical criteria. Morphological methods depending upon an assessment of overall size and the development of features like forehead shape and supraorbital development (Krogman 1955; Larnach and Freedman 1967). Metrical methods commonly involve the linear combination of a number of cranial dimensions and discriminant function analysis (Hanihara 1959; Giles and Elliot 1963; Snow et al. 1979). Both methods are able to obtain accuracies greater than 85 percent.

The human cranium is also the most often studied part of the skeleton in documenting geographic variation and "racial" classification. The latter is a particularly controversial topic for some American anthropologists (Shipman 1994; Brace 1994; Kennedy 1995) and will be discussed later in this booklet. Perhaps the most important analyses of geographic variation in human cranial form are those of Howells (1973, 1989, 1995). While Howells's multivariate methods could easily distinguish average cranial shape and size from different regions, there was also considerable overlap (clines) between groups. The presence of these clines, as well as those at many genetic loci, is one of the major problems with the biological definition of race. Morphological studies of "racial" variation in human crania include Wood-Jones (1930/31), Todd and Tracy (1930) and Krogman (1955). Multivariate statistical studies are now more common and these include Giles and Elliot (1962), Snow et al. (1979), Gill et al. (1986) and Howells (1970). Metrical and morphological descriptions of Australian Aboriginal crania can be found in Klaatsch (1908), Fenner (1939), Larnach and Macintosh (1966, 1970), Brown (1973), Pietrusewsky (1984) and Brown (1989).

The mandible



The tooth bearing mandible is the largest and strongest bone of the facial skeleton and preferentially preserves in archaeological and palaeontological deposits. The horizontal body of the mandible is curved and joined to two relatively vertical rami. At birth the mandible is in two separate halves, joined at the median plane of the symphysis by fibrous tissue. Union of the two halves is completed by 12 months of age. Articulation with the cranium is through the condyle of the ramus and mandibular fossa of the temporal bone. Masticatory movements of the mandible are primarily through the action of the temporal, masseter and pterygoid muscles which attach to the lateral and medial surfaces of the ramus.

Mandibles have provided useful information in studies of sexual dimorphism, geographic variation and evolutionary change in morphology. Giles (1964, 1970) using discriminant function analysis and combinations of up to eight mandibular dimensions was able to correctly sex mandibles with an accuracy of up to 87 percent. Morphological comparisons concentrating on aspects of absolute size, gonial eversion and the presence, or absence, of tubercles and tori have obtained similar levels of accuracy (Larnach and Macintosh 1971; Brown 1989). Evidence for significant levels of geographic variation in mandibular size and shape are more controversial. Morant (1936) argued that racial differences in the mandible were virtually non-existent, while Schultz (1933) had earlier argued that some clear morphological divisions were present. My own research supports Schultz's observation and this issue will be discussed later in your booklet.

Descriptive and metrical information on Australian Aboriginal mandibles can be found in Klaatsch (1908), Murphy (1957), Larnach and Macintosh (1971), Freedman and Wood (1977) and Brown (1989). Of these Murphy (1957) provides a description of the symphyseal region and Larnach and Macintosh (1971) a thorough coverage of discrete and continuous mandibular morphology. Geographic variation and diachronic change are examined in Brown (1989). Richards (1990) discusses the association between dental attrition and degenerative arthritis in Aboriginal temporomandibular joints. Descriptive dimensions for mandibles from a variety of human populations can be found in the sections on sex determination and geographic variation in this booklet.

The scapula

The scapula is a large, flattened, triangular shaped bone located on the posterolateral part of the thorax. It has two main surfaces, costal and dorsal and three bony processes consisting of the spine, the acromion and coracoid processes. Laterally, at the glenoid cavity, the scapular articulates with the head of the humerus. The cartilaginous scapula is ossified from eight centres. Epiphyseal union on the acromion occurs at approximately 18-19 years of age and the lower angle and medial (vertebral) border at 20-21 years. Age related changes in the scapula have been studied in detail by Graves (1922) who concentrated on postmaturity ossification and atrophic processes.

In comparison to many of the other bones in the human skeleton the scapula has been rarely studied. To a large degree this is a reflection of poor preservation in most osteological collections. The bone above and below the spine, extending to the superior and inferior borders, is thin, fragile and easily broken. Sample sizes are therefore often inadequate for description and statistical comparison. Methods of sex determination for adult scapula have been described by Bainbridge and Genoves (1956) and Hanihara (1959). Using discriminant function analysis, with as few as four measurements, Hanihara was able to achieve an accuracy of 97 percent with Japanese scapula. Dongen (1963) studied Australian Aboriginal scapula as part of his description of the shoulder girdle and humerus. Mean dimensions of a small series of prehistoric Australian Aboriginal scapula from southeastern Australia are provided in table 3.

	n	$\overline{X}$	sd
Left scapula maximum length			
Male	45	146.1	10.94
Female	35	129.0	6.47
Left scapula breadth			
Male	56	97.3	5.49
Female	52	88.1	4.94
Left scapula spine length			
Male	31	133.2	6.72
Female	33	120.2	5.76
Left scapula vertical glenoid diameter			
Male	34	34.8	2.23
Female	33	30.7	1.44

Table 3. Dimensions of male and female Aboriginal scapula (mm)

The clavicle

The clavicle runs fairly horizontally from the base of the neck to the shoulder. It functions as a prop which supports the shoulder and allows greater mobility in the arm, partly by transmitting weight to the shoulder. The lateral, or acromial end is flattened and articulates with the acromion of the scapula. Medially the clavicle articulates with the clavicular notch on the manubrium and the shaft has an enlarged sternal end. The shaft of the clavicle is bow shaped in the medial two thirds of its length, with the curvature recurving in the opposite direction around the coronoid tubercle. There are three centres of ossification in the clavicle. Two of these are located mid-shaft and there is a secondary centre at the sternal end. Epiphyseal union at the sternal end occurs at an average of 25-28 years and the acromial end at 19-20 years (Krogman and Iscan 1986).

Clavicles rarely feature in osteological reports of either a forensic or anthropological orientation. This may be due to the relative simple shape of the clavicle, with limited evidence for geographic or sex based variation. As far as I am aware there not been any substantive attempts to examine age related changes in the clavicle. However, Jit and Singh (1966) present information on sex based variation in South Asian clavicles and Longia et al. (1982) look at metrical variation in the rhomboid fossa in relation to handedness. Ray (1959) provides at detailed morphological and metrical description of a large series of Australian Aboriginal clavicles. Descriptive dimensions for male and female Aboriginal clavicles from southeastern Australia can be found in table 4.

	n	$\bar{X}$	sd
Left clavicle maximum length			
Male	89	139.6	8.79
Female	92	125.3	7.99
Left clavicle acromial breadth			
Male	52	21.4	2.90
Female	52	17.9	2.71
Left clavicle sternal breadth			
Male	25	24.9	2.67
Female	26	20.7	1.63

Table 4. Dimensions of male and female Aboriginal clavicles (mm)

The humerus

The humerus is the longest and most robust bone of the arm. It comprises a cylindrical shaft, a broad and flattened distal end and a rounded articular surface on the proximal end. The head of the humerus articulates with the glenoid cavity of the scapula in a ball and socket joint. The articular surface of the distal end is condylar in form and articulates with the radius and ulna of the forearm. Ossification of the humerus is complex as eight different centres are involved. One of these is in the shaft, the others in the greater and lesser tubercle, the capitulum, the medial part of the trochlea and each of the epicondyles. Epiphyseal union in young male adult humeri was studied in detail by McKern and Stewart (1957). The proximal epiphysis fuses at 19.5-20.5 years, distal epiphysis at 14-15 years and the medial epicondyle at 15-16 years.

The humerus has received a moderate amount of attention in the forensic and anthropological literature. Schranz (1959) and Nemeskeri et al. (1960) describe age related changes in the proximal humerus of adults, which largely consist of the extension of the medular cavity and reduction in trabecula bone. Sex determination and sexual dimorphism in humerus dimensions and morphology have been examined by Godycki (1957), Singh and Singh (1972) and Steel (1972). When used by itself the humerus does not provide one of the more accurate means of sex determination. In combination with other bones, however, classification accuracies of greater than 95 percent have been obtained using discriminant functions (Thieme 1957; Hanihara 1958). Regression equations for the calculation of adult stature from humerus length have been developed for a number of different human populations, for instance Trotter and Glesser (1952), Shitai (1983), and Lundy (1983). Errors for estimation of stature from the humerus are normaly of the order of ± 4.5 cm which is greater than the errors for most other long bones. A morphological and metrical description of Australian Aboriginal humeri can be found in Dongen (1963). Descriptive dimensions for male and female Aboriginal humeri from southeastern Australia are listed in table 5.

	n	$\overline{X}$	sd
Left humerus maximum length			
Male	195	323.9	16.22
Female	147	303.5	16.05
Left humerus maximum mid-shaft breadth			
Male	95	19.8	1.72
Female	101	17.1	1.60
Left humerus minimum mid-shaft breadth			
Male	92	15.6	1.49
Female	73	12.8	1.29
Left humerus vertical head diameter			
Male	89	41.6	2.36
Female	88	36.5	2.12
Left humerus distal articular surface breadth			
Male	59	42.0	2.33
Female	73	37.3	2.21

Table 5. Dimensions of male and female Aboriginal humeri (mm)

The radius and ulna 

The radius and ulna are the bones of the forearm which articulate with the humerus at their proximal end and bones of the wrist at their distal end. The ulna is the medial bone of the forearm and is parallel with the radius when the arm is supine. It has a large hook-like articular surface on the proximal end and the somewhat angular shaft decreases in size to the rounded head and styloid process of the distal end. Articulation with the radius is at the radial notch and head. The radius is the lateral bone of the forearm. It has a rounded proximal head, prominent radial tuberosity and expanded distal end with a large articular surface. The distal end of the radius articulates with the lunate and scaphoid bones of the wrist. Epiphyseal union of the head of the radius occurs at 14-15 years, the proximal ulna at 14.5-15.5 years, distal radius and ulna at 18-19 years.

These bones have not had a major role in forensic and anthropological research. Sex determination formulae for the radius and ulna, however, have been developed by Steel (1972) using a small English sample of known age and sex. Regression equations for the calculation of adult stature from radius and ulna length are available for a number of different human populations, for instance Trotter and Glesser (1952), Shitai (1983), and Lundy (1983). Errors for estimation of stature from the radius and ulna are similar to the humerus, around ± 4.5 cm which is greater than the errors for most other long bones. Kennedy (1983) assesses morphological variation in the supinator crests and fossae of ulna as indicators of occupational stress. There are no published descriptions of Aboriginal radius and ulna but length data are provided in table 6.

	n	$\bar{X}$	sd
Left radius maximum length			
Male	134	252.7	13.19
Female	95	231.5	13.9
Left ulna maximum length			
Male	127	269.9	12.47
Female	82	247.9	14.22

Table 6. Dimensions of male and female Aboriginal radius and ulna (mm)

The hand

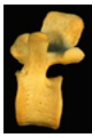
The hand and fingers are supported by a complex structure of 26 bones. Fourteen of these are phalanges, five metacarpals and the remaining seven are carpal bones in the proximal part of the hand. Each of the fingers has three phalanges and the thumb two. Each of the carpal bones ossifies from a single centre, the capitate first and the pisiform last. Ossification of the carpals occurs earlier in females than in males and is normaly completed by 12 years (Beresowski and Lundie 1952). The metacarpals all ossifie from two centres, a primary centre in the shaft and a secondary centre in the proximal end of metacarpal one and the distal end of metacarpals two to five. Epiphyseal union in the metacarpals is normaly completed by 15-16 years of age.

Metacarpals have been used to provide information on stature (Musgrave and Harneja 1978; Meadows and Jantz 1992) and the identification of sex (Lazenby 1994; Scheuer and Elkington 1993; Falsetti 1995). For stature estimation errors range between ±5-8 cm depending upon which metacarpal is being used, with the worst results for metacarpal five. Sex determination using metacarpal dimensions is also problematic and would not be considered a favoured option if alternatives were available. Mean dimensions of male and female Aboriginal metacarpals are provided in table 7.

	n	$\overline{X}$	sd
right metacarpal 1 length			
Male	143	46.6	3.49
Female	120	44.9	2.68
right metacarpal 2 length			
Male	143	67.9	4.48
Female	120	65.6	3.23
right metacarpal 3 length			
Male	143	65.7	4.44
Female	120	63.5	3.49
right metacarpal 4 length			
Male	143	58.7	3.96
Female	120	56.8	3.34
right metacarpal 5 length			
Male	143	52.9	3.77
Female	120	51.0	2.93

Table 7. Dimensions of male and female Aboriginal metacarpals (mm).

The spinal column



The human spinal column normaly contains 24 vertebra, seven cervical, 12 thoracic and five lumbar. The first cervical vertebra, or atlas, articulates with the occipital condyles of the cranial base. As a group the cervical vertebra are identifiable by their small size and presence of transverse processes which are perforated by foramen. The first two cervical vertebra, atlas and axis, are particularly distinctive. Atlas has a large vertebral foramen and no body and axis has a prominent process, the dens, projecting from the superior surface of the body. The twelve thoracic vertebra, each with costal facets for articulation with the ribs, increase in size downwards. Additional facets are also found on the transverse processes of the first 10 thoracic vertebra for articulation with the tubercles of the ribs. The lumbar vertebra are the largest and most robust in the vertebral column. They have particularly broad bodies and the vertebral foramen is triangular in shape. The fifth lumbar vertebra articulates with the sacrum.

Vertebra have had only a minor role in forensic and anthropological research. To some degree this is due to the fragility of vertebra, particularly their bodies, and their poor representation in osteological collections. Their major contribution has been in studies of age related osteoarthritic change, congenital defects and pathology (Ortner and Putschar 1989) and stature estimation. To reconstruct stature the vertebral column needs to be intact as estimations from a single vertebrae contain extremely large errors. Tibbetts (1981) provides regression formulae for the combined lengths of various groups of vertebrae based on data from a pooled sex Afro-American skeletal series. The vertebral column also contributes to the skeletal height methods of stature estimation pioneered by Fully (1956) and Fully and Pineau (1960).

The sacrum

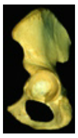
The sacrum is a large triangular shaped bone formed by the fusion of five sacral vertebrae. It is located in the upper and posterior part of the pelvic cavity and base of the back. The two innominates articulate with the sacrum as does the fifth lumbar vertebra and coccyx. When standing erect the bone is very oblique and is curved longitudinally, with a marked concavity on the pelvic surface. The dorsal surface has large areas of attachment for the erector spinae, multifidus and gluteus maximus muscles of the lower back and thigh.

The principal contribution of the sacrum to forensic osteology is in the areas of sex determination, age estimation and parturition. Metrical studies have emphasize the relatively short but broad female sacra (Flander 1978; Kimura 1982), with Kimura's base-wing index correctly sexing about 80 percent of male and female sacra. Alteration of the anterolateral margin of the auricular surface due to pregnancy and childbirth has been examined by Ullrich (1975) and Kelly (1979). Both authors argue that reliable information as to pregnancy and childbirth is present, but not the number of births. Morphological and metrical information on Australian Aboriginal sacra is available in Davivongs (1963a) study of the pelvic girdle. Mean dimensions of male and female Aboriginal sacra are provided in table 8.

	n	$\overline{X}$	sd
Sacrum maximum length			
Male	66	97.1	7.14
Female	62	89.4	7.01
Sacrum maximum breadth			
Male	74	100.9	4.98
Female	82	101.7	5.26

Table 8. Dimensions of male and female Aboriginal sacra (mm)

The innominate



The innominate is a large irregularly shaped bone which when viewed laterally is constricted in the middle and expanded at either end. Each innominate consists of three parts, the ilium, the ischium and the pubis. These are separated in infants, with union between the three elements in the pubertal growth period. Growth continues at the epiphyses of the iliac crest, ischial tuberosity and pubic ramus. Union of the entire innominate is normaly completed by 23 years of age. On the lateral surface of the innominate there is a cup-shaped depression called the acetabulum which articulates with the head of the femur. Below this is a large oval shaped hole, the obturator foramen. On the superior part of the medial surface the innominate articulates with the sacrum at the auricular surface. The left and right innominates join ventrally at the pubic symphysis.

Due to its links with child birth the gynaecological pelvis, of which the innominates form a substantial part, has received considerable attention in the literature on sex determination. Differences between adult male and female pelves are apparent in overall size, proportions and morphology (Krogman 1955; Phenice 1969; Schulter-Ellis et al. 1983; Novotny 1983; Sutherland and Suchey 1991). However, there remains a persistent overlap in the male and female ranges of variation. An accuracy of 85-90 percent is probably the best that can be achieved when sex determination is based entirely on the pelvis or a single innominate. The pelvis has also provided information on "race" determination (Iscan 1981), pregnancy and childbirth (Ullrich 1975) and age at death (Gilbert and McKern 1973; Lovejoy et al. 1985). The Australian Aboriginal pelvic girdle was described by Davivongs (1963a) and mean dimensions of male and female Aboriginal innominates are listed in table 9.

	n	$\overline{X}$	sd
Left innominate maximum length			
Male	50	197.1	8.98
Female	48	181.7	7.20
Left innominate iliac breadth			
Male	48	148.1	6.86
Female	47	141.8	7.51
Left innominate pubic length			
Male	64	64.8	5.24
Female	47	70.3	5.73
Left innominate ischial length			
Male	74	80.8	3.99
Female	60	74.1	3.66
Left innominate ischium-pubis index			
Male	46	78.5	3.87
Female	37	93.0	6.07
Left acetabulum vertical diameter			
Male	50	51.4	2.74
Female	50	45.9	1.99

Table 9. Dimensions of male and female Aboriginal innominates (mm)

The femur

The femur is the longest and strongest bone in the body, with the thickened shaft preferentially preserving in archaeological deposits. The shaft of the femur is fairly cylindrical and bowed with a forward convexity. On its proximal end a rounded articular head projects medially on a short neck and articulates with the acetabulum of the innominate. Distally the shaft expands into a broad, double condyle which articulates with the tibia. The femur has five ossification centres, one each in the shaft, head, greater and lesser trochanter and distal end. Epiphyseal union is normaly completed by 17-18.5 years, with the distal epiphyses closing last of all.

Femora are able to provide information for purposes of stature estimation, sex determination and the identification of regional, or “racial”, origin. Stature estimation formulae involving the femur, particularly the femur in combination with the tibia, have smaller errors than any of the other long bones. Trotter and Glesser (1952) report errors of approximately 3.3-3.6 cm, which is greater than the errors obtained in more recent studies (Lundy 1983; Shitai 1983). Simmons et al. (1990) test methods of stature estimation using fragmentary femora.

	n	$\bar{X}$	sd
Left femur maximum length			
Male	157	453.1	17.95
Female	98	421.0	21.72
Left femur a-p midshaft breadth			
Male	171	28.1	2.53
Female	110	23.8	2.40
Left femur m-l midshaft breadth			
Male	169	25.1	1.79
Female	102	22.6	1.53
Left femur vertical head diameter			
Male	156	43.1	2.36
Female	111	38.4	2.12
	64	62.1	3.69

Table 10. Dimensions of male and female Aboriginal femora (mm)

The tibia and fibula 

The tibia is the medial and strongest bone of the lower part of the leg and is the second largest bone in the human skeleton. Proximally the tibia has a broad articular surface which articulates with the femur. The shaft is prismoid in section, with a sharp crest running down much of the anterior border. Distally the shaft is also expanded with a prominent process, the medial malleolus. The fibula is a much more slender bone than the tibia and occupies a lateral position in the lower leg. The shaft is somewhat angular in cross section and variable in form, depending upon individual muscle development. Proximally the shaft expands into a bulbous head, while the distal end expands into the lateral malleolus. Both the tibia and fibula are ossified from three centres, one in the shaft and one for each end. Epiphyseal union in the proximal tibia and fibula takes place at approximately 17.5 to 18.5 years and distally at 15.5 to 16.5 years.

While there are a number of studies on morphological and metrical variation in the tibia (Wood 1920; Hanihara 1958; Steel 1972; Iscan and Miller Shaivitz 1984; Iscan et al. 1994) the fibula has been largely ignored. Several formulae for determining the sex of tibia using discriminant function analysis have been developed, with accuracy varying between 85 and 95 percent (Hanihara 1958; Iscan and Miller-Shavitz 1984; Liu et al. 1989). Stature estimation formulae for isolated tibia have slightly larger errors than those for the femur (Trotter and Gleser 1958; Lundy 1983; Shitai 1983) but formulae for combined femur and tibia lengths provide errors <±2 cm. Information on geographic origin may also be obtained from tibia dimensions, particularly relative to those of other limb bones (Schultz 1937). This is in accordance with Berghmann’s (1847) rule where relative limb proportions vary around the globe in relation to climate and the need to control deep core temperature.

A pooled sex group of Australian Aboriginal tibia were studied by Wood (1920) and Rao’s (1966a) thesis examines the size and morphology of all distal limb segments. Rao (1966b) also presents information on the frequency of squatting facets. A comparison of Broadbeach, Queensland, and coastal Adelaide femora and tibiae was completed by Murphy (1978) for her Masters thesis and table 11 provides mean data for male and female Aboriginal tibiae.

	n	$\overline{X}$	sd
Left tibia spino-mall length			
Male	133	378.5	18.57
Female	89	355.0	18.49
Left tibia condyle-mall length			
Male	135	374.9	18.44
Female	85	351.0	19.17
Left tibia min. m-d diameter at nutrient foramen			
Male	176	21.7	1.85
Female	114	18.8	2.26
Left tibia a-p diameter at nutrient foramen			
Male	65	33.8	2.76
Female	54	27.2	3.22
Left tibia proximal epiphyses breadth			
Male	150	71.3	3.68
Female	83	62.7	3.51

Table 11. Dimensions of male and female Aboriginal tibiae (mm)

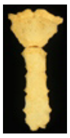
The foot


The skeleton of the foot is made up of 27 bones, excluding sesamoids, and can be divided into three sections: the tarsus, the metatarsus and the phalanges. The seven bones of the tarsus make up the posterior section of the foot, with the calcaneus forming the heel. Articulation with the tibia is through the trochlear surface of the talus. The cuboid and cuneiform bones articulating with the five metatarsals. Each of the toes, apart from the first or great toe, are made up of three phalanges. The first toe has only two.

There have been very few studies on the tarsal and metatarsal bones from a forensic or anthropological perspective. Steele (1976) examined sex and “race” differences in the dimensions of the calcaneus and talus. Significant levels of sexual dimorphism were present but there was no evidence of “racial” differences. The only publication on Australian

Aboriginal foot bones appears to be Rao (1966b) which examined the frequency and morphology of squatting facets on tibiae and tali.

The sternum and ribs



The sternum is divided into three sections: the manubrium, body of sternum and xiphoid process. Located at the midline of the chest, the sternum is inclined downwards and a little forward. Broadest at the clavicular notch, narrows at the junction of the manubrium and then expands slightly towards the facet for the 5th costal cartilage. Relatively fragile, the sternum is often poorly preserved in archaeological and forensic situations. There are normaly twelve pairs of ribs, the first seven pairs connecting to the sternum through the costal cartilages. Three of the remainder are connected through cartilage to the ribs above and ribs eleven and twelve are free at their anterior ends. All of the ribs articulate with the thoracic vertebrae at their posterior end, with the majority having articular facets on the head and tubercle. Rib shafts, which are elastic and fragile arches of bone, tend to decay rapidly in archaeological and forensic situations.

Sex differences in the sternum are based on overall size and proportions (Jit et al. 1980; Stewart and McCormack 1983). Studies of sexual dimorphism in rib dimensions have not been undertaken but age related change in the sternal end of the rib may provide important forensic information. Iscan et al. (1984, 1985) have developed two methods, component and phase analysis, to estimate age from the morphology of the sternal end. Age estimation errors are fairly small, ±1.5 years, for people in their late teens but increase to ±15 years at around 50 years of age. There are no published data on Australian Aboriginal sterna or ribs.

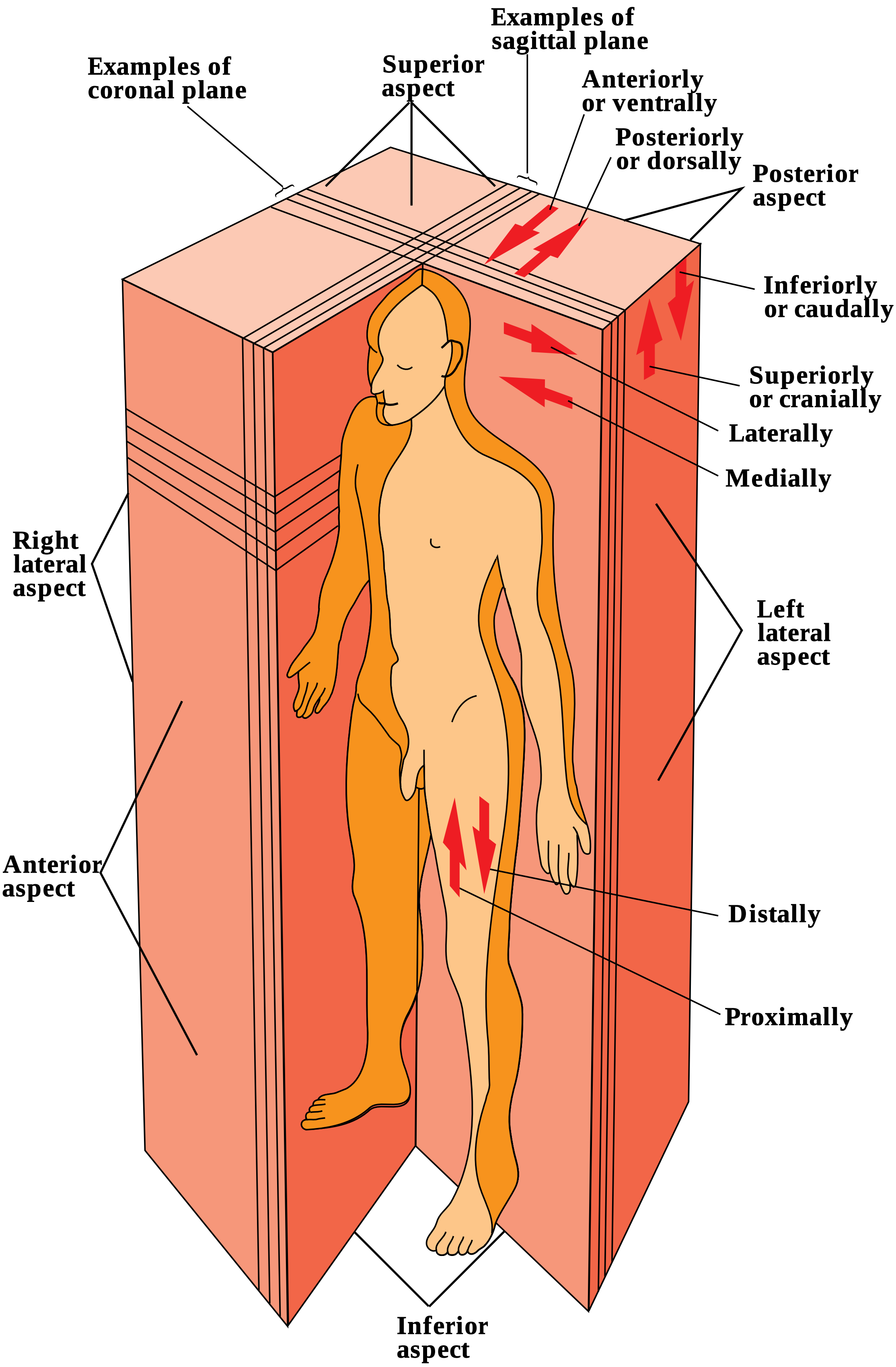


Figure 38. Descriptive anatomical terminology for navigating around the body (adapted from Warwick and Williams 1973:xiv).

Bones of the head	plurals
coccyx	coccyges
concha	conchae
ethmoid	ethmoids
frontal	frontals
hyoid	hyoids
incus	incudes
lacrimal	lacrimals
malleus	mallei
mandible	mandibles
maxilla	maxillas or maxillae
nasal	nasals
occipital	occipitals
palate	palate bones
parietal	parietals
sphenoid	sphenoids
stapes	stapeses
temporal	temporals
vomer	vomers
zygomatic (malar)	zygomatics (malars)

Back and thorax	plurals
gladiolus	gladioluses or gladioli
manubrium	manubriums or manubria
rib	ribs
sacrum	sacra
sternum	sterna or sternums
vertebra	vertebrae
xiphoid	xiphoids

Upper limb	plurals
capitate	capitates
carpal	carpals
clavicle	clavicles
greater and lesser multangular	multangulars
hamate	hamates
humerus	humeri
lunate	lunates
navicular	naviculars
phalange	phalanges
pisiform	pisiforms
scapula	scapulae
triquetrum	triquetrums
ulna	ulnae

Lower limb and pelvis	plurals
calcancus	calcaneuses or calcanea
cuboid	cuboids
cuneiform	cuneiforms
femur	femora
fibula	fibulas or fibulae
ilium	ilia
innominate	innominates
ischium	ischia
patella	patellae
pubis	pubes
symphysis	symphyses
talus	tali
tarsal	tarsals
tibia	tibias or tibiae

Table 12.The names of individual bones and their plurals.

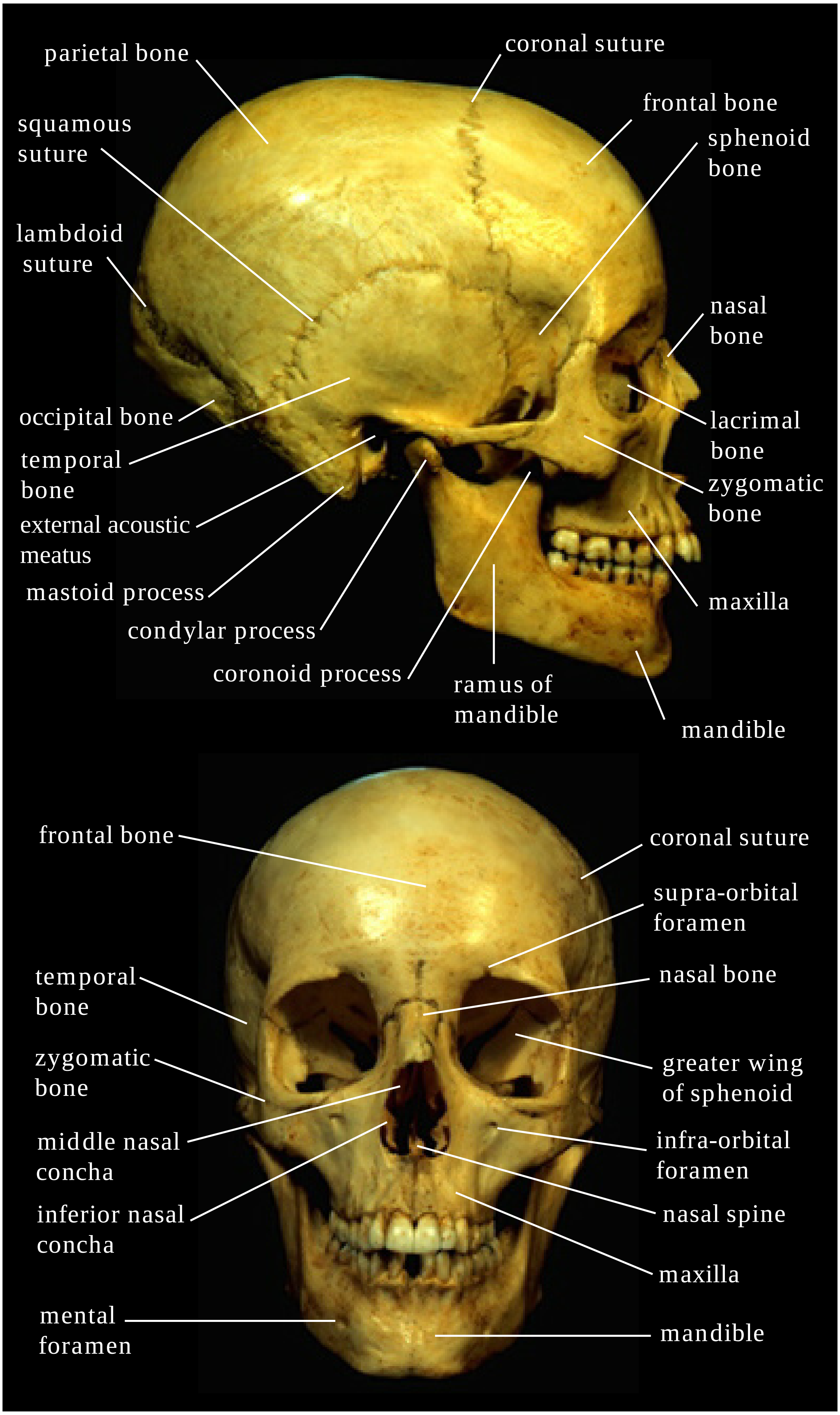


Figure 39. The cranium, lateral and anterior views.

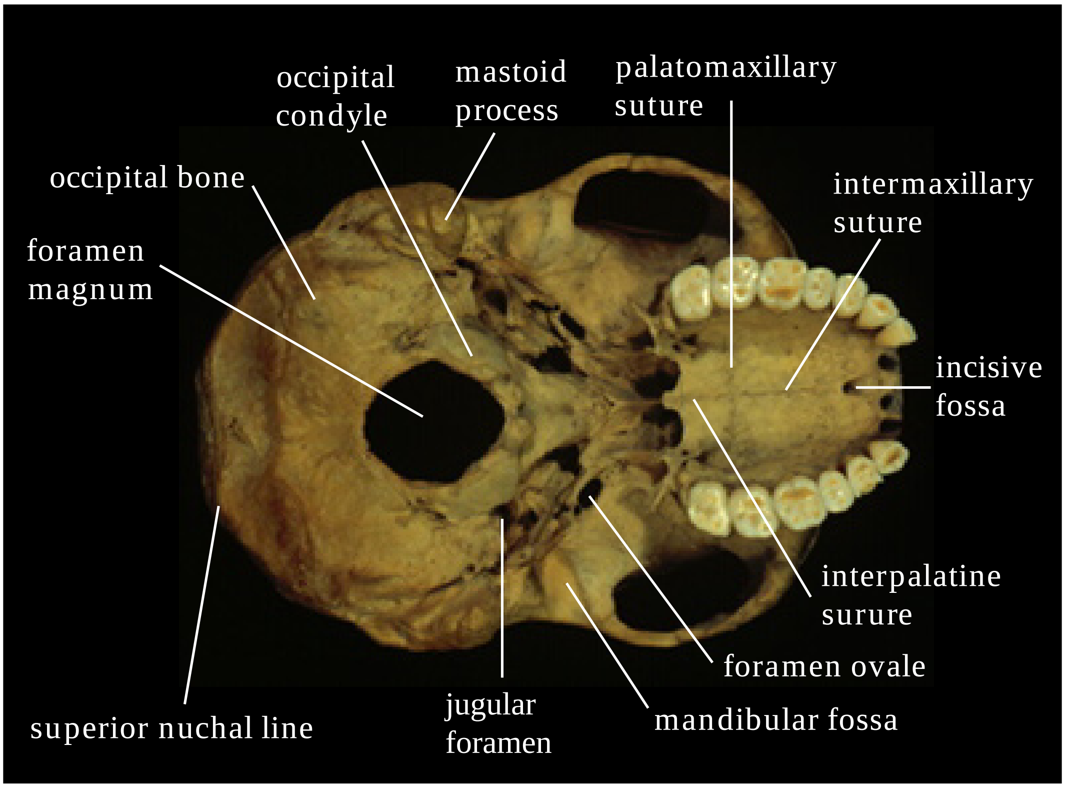


Figure 40. The cranium, inferior or basal view.

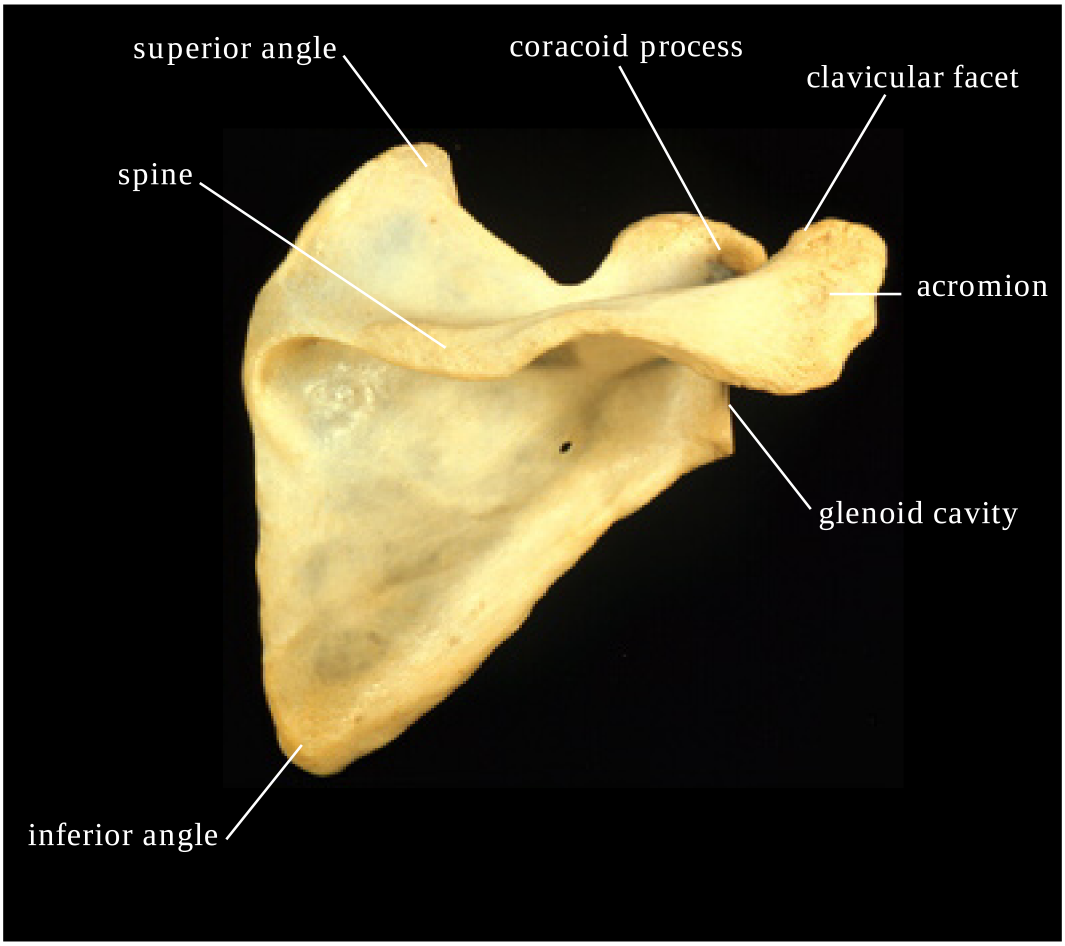


Figure 41. The right scapula, dorsal view.

Figure 42. The left clavicle, dorsal view.

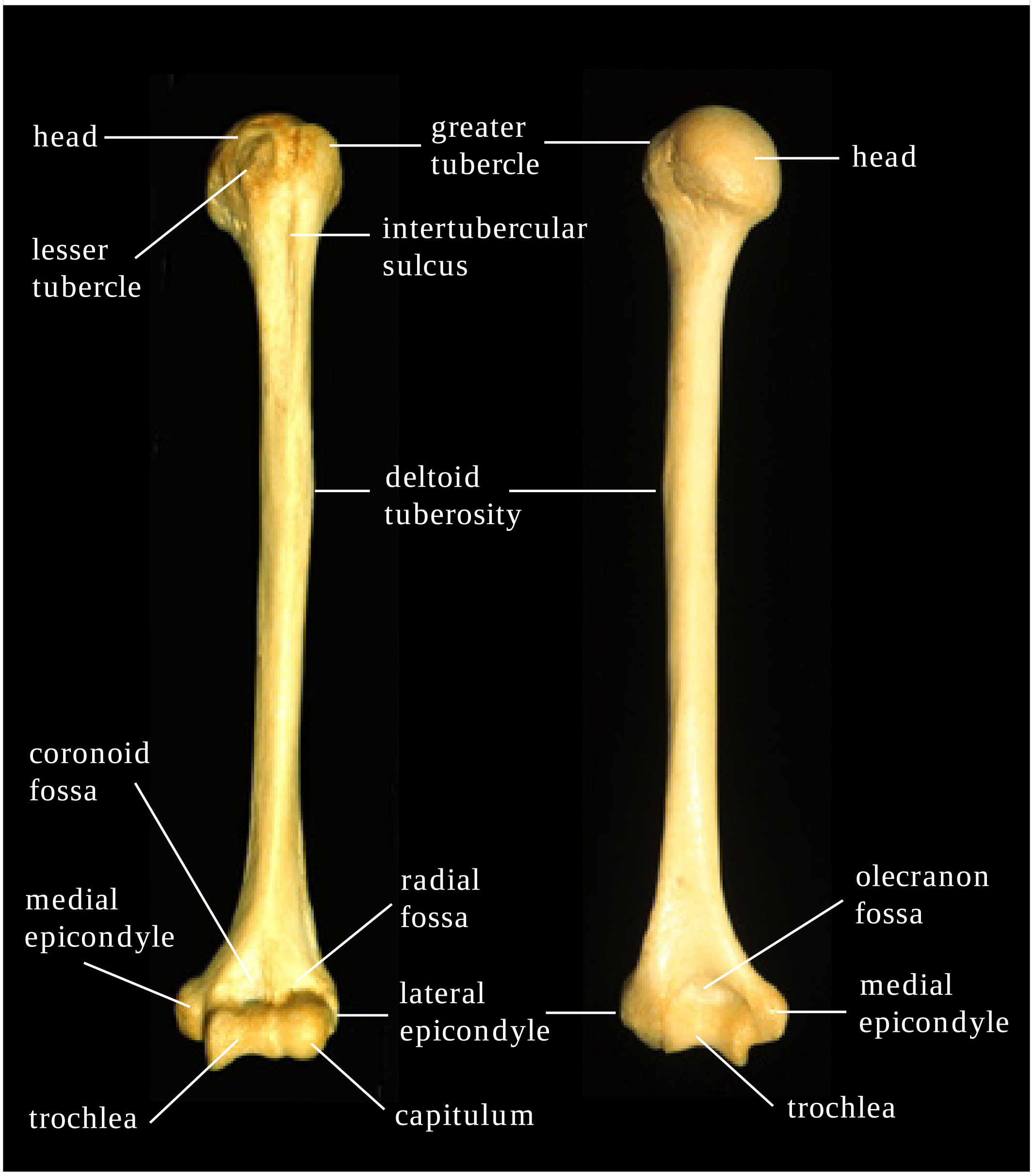


Figure 43. The left humerus, anterior and posterior views.

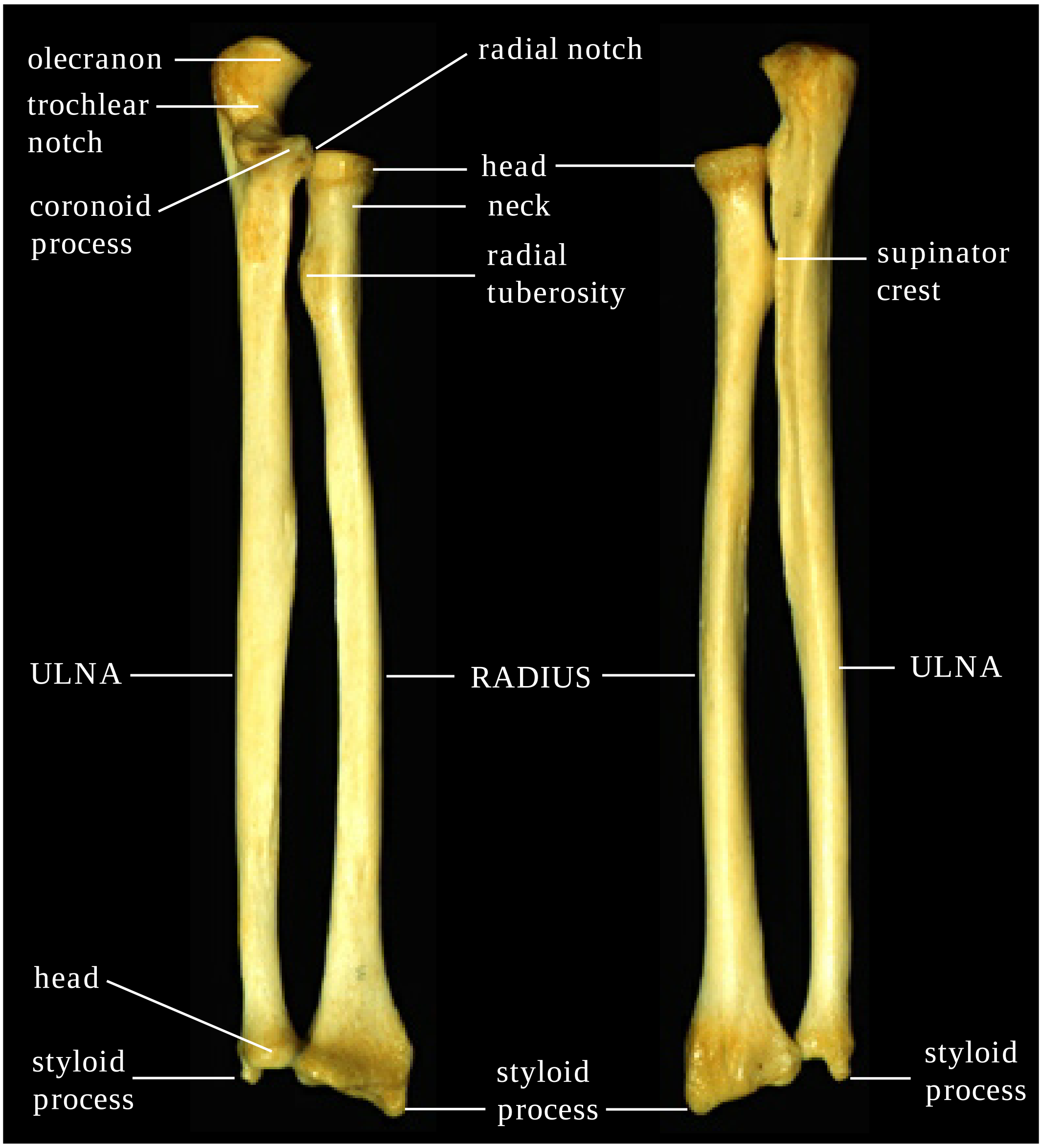


Figure 44. The bones of the left forearm, anterior and posterior views.

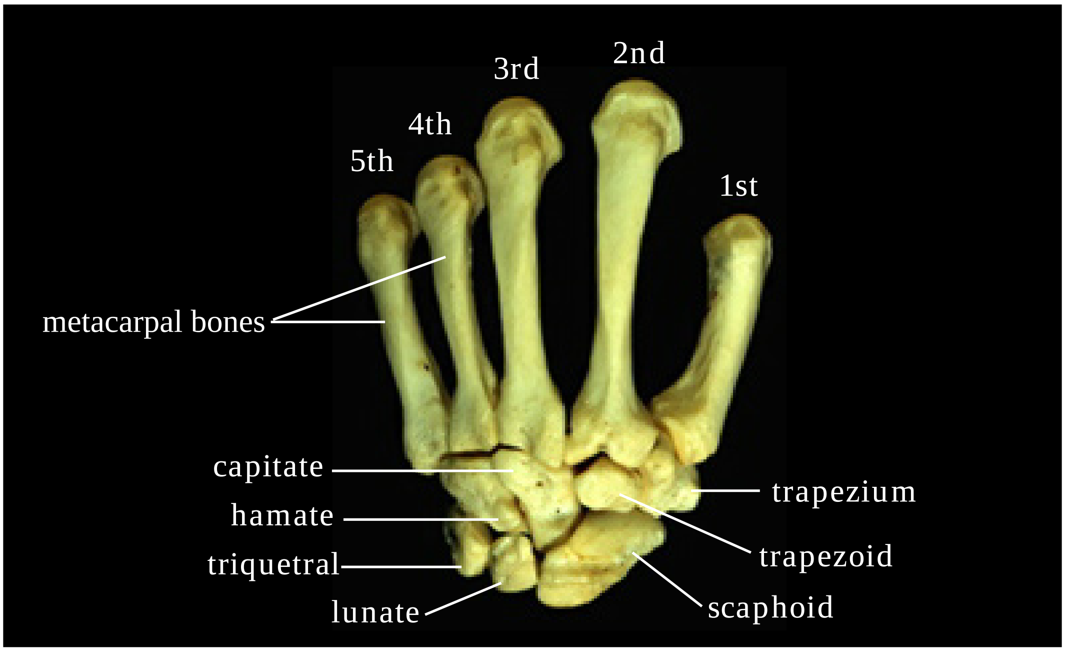


Figure 45. The carpal and metacarpal bones of the left hand, dorsal view.

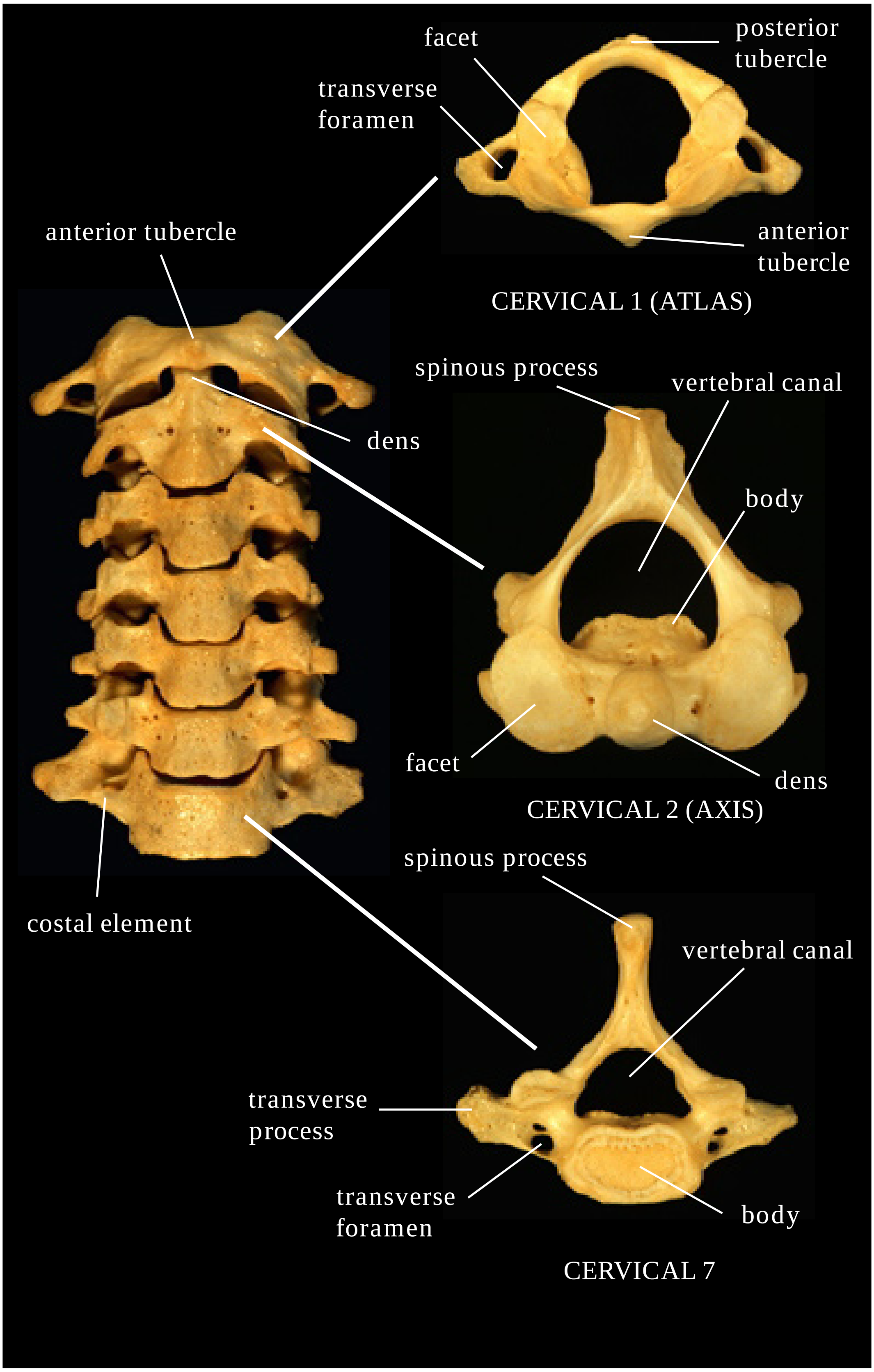


Figure 46. The cervical vertebrae, anterior view, and superior views of cervical 1, cervical 2 and cervical 7 (not to scale).

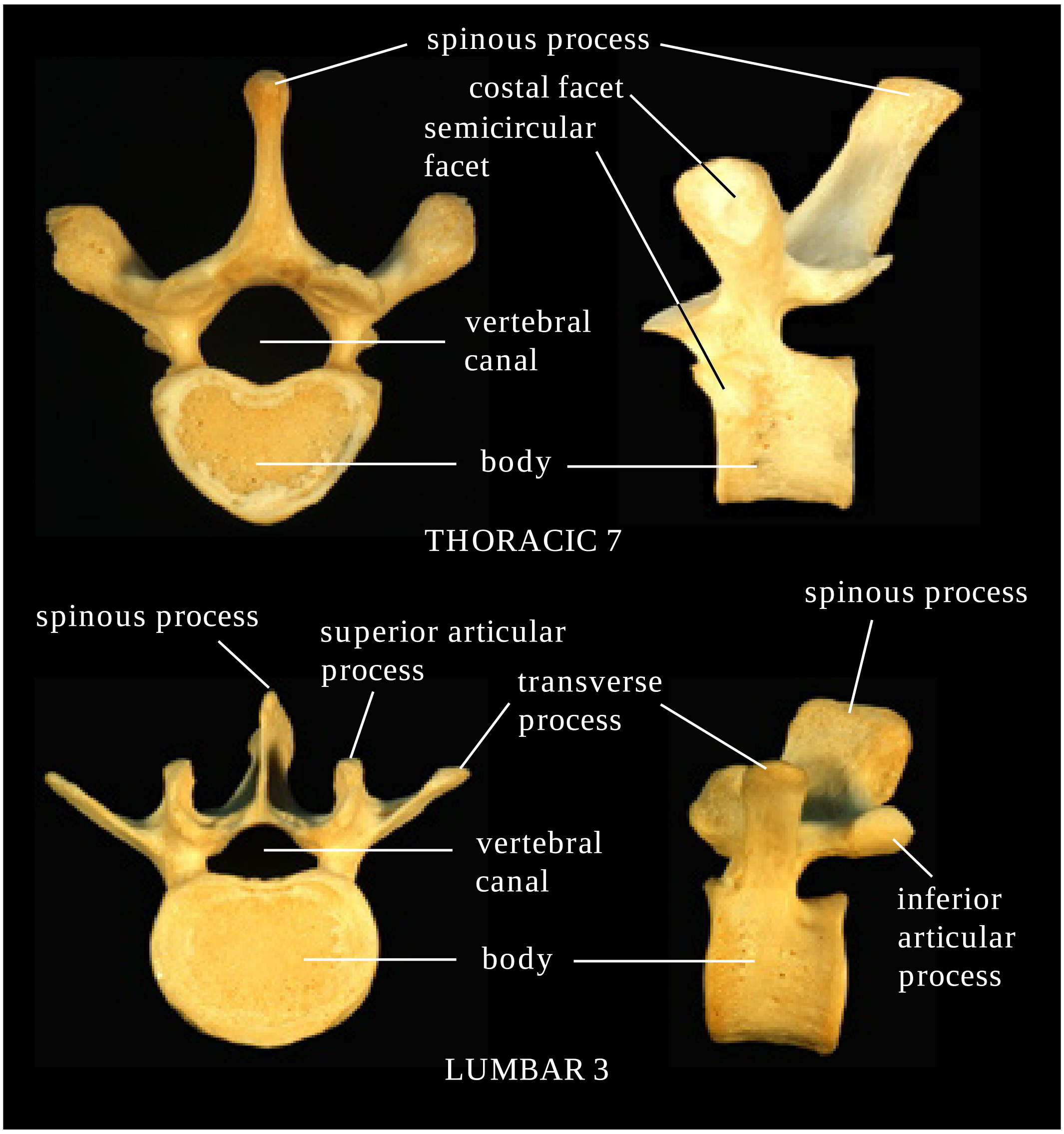


Figure 47. Thoracic and lumbar vertebrae (not to scale).

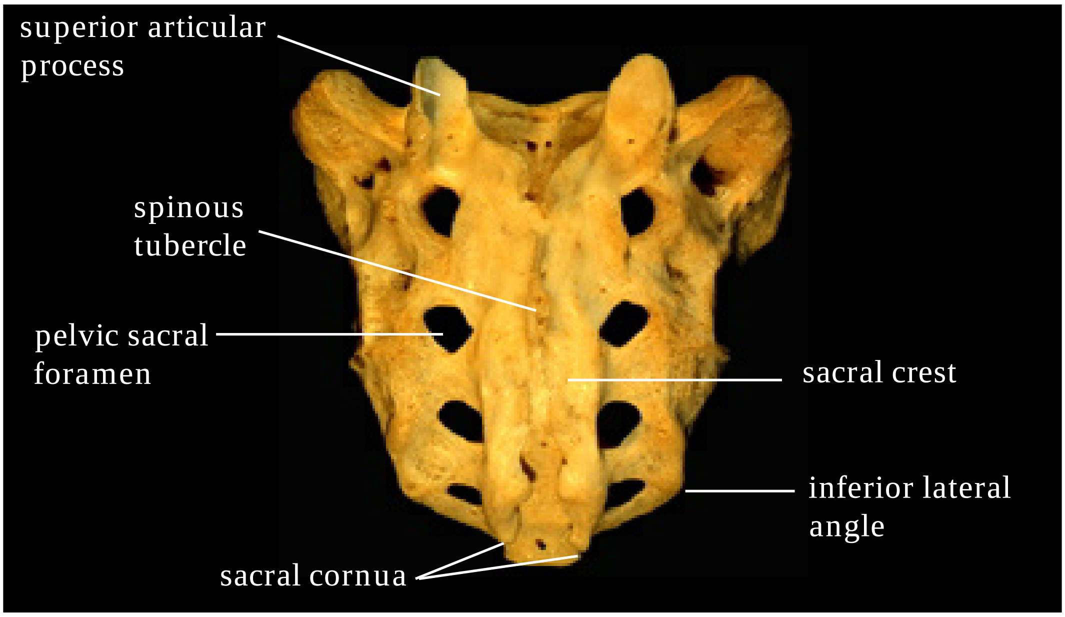


Figure 48. The sacrum, dorsal surface.

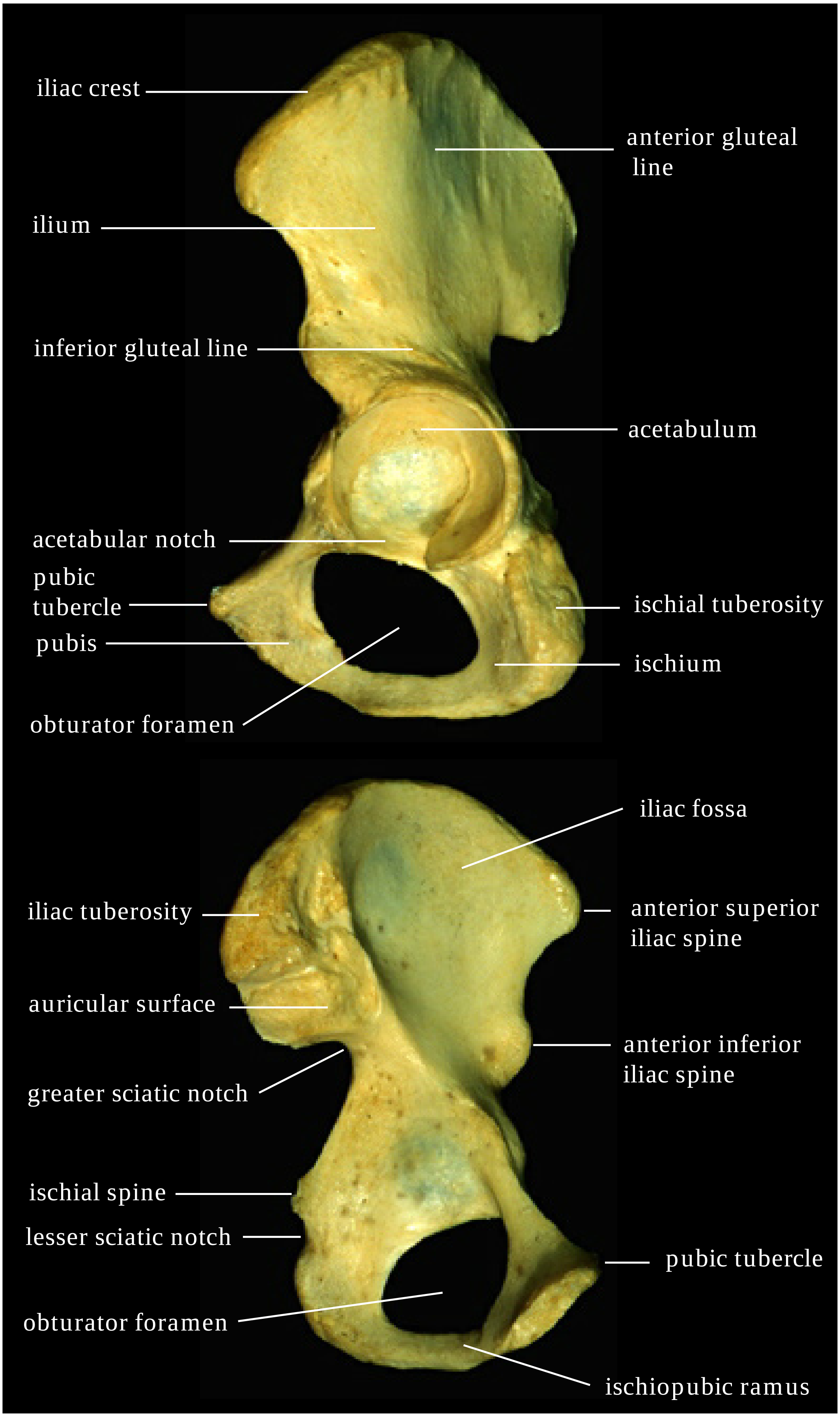


Figure 49. Left innominate, lateral and medial views.

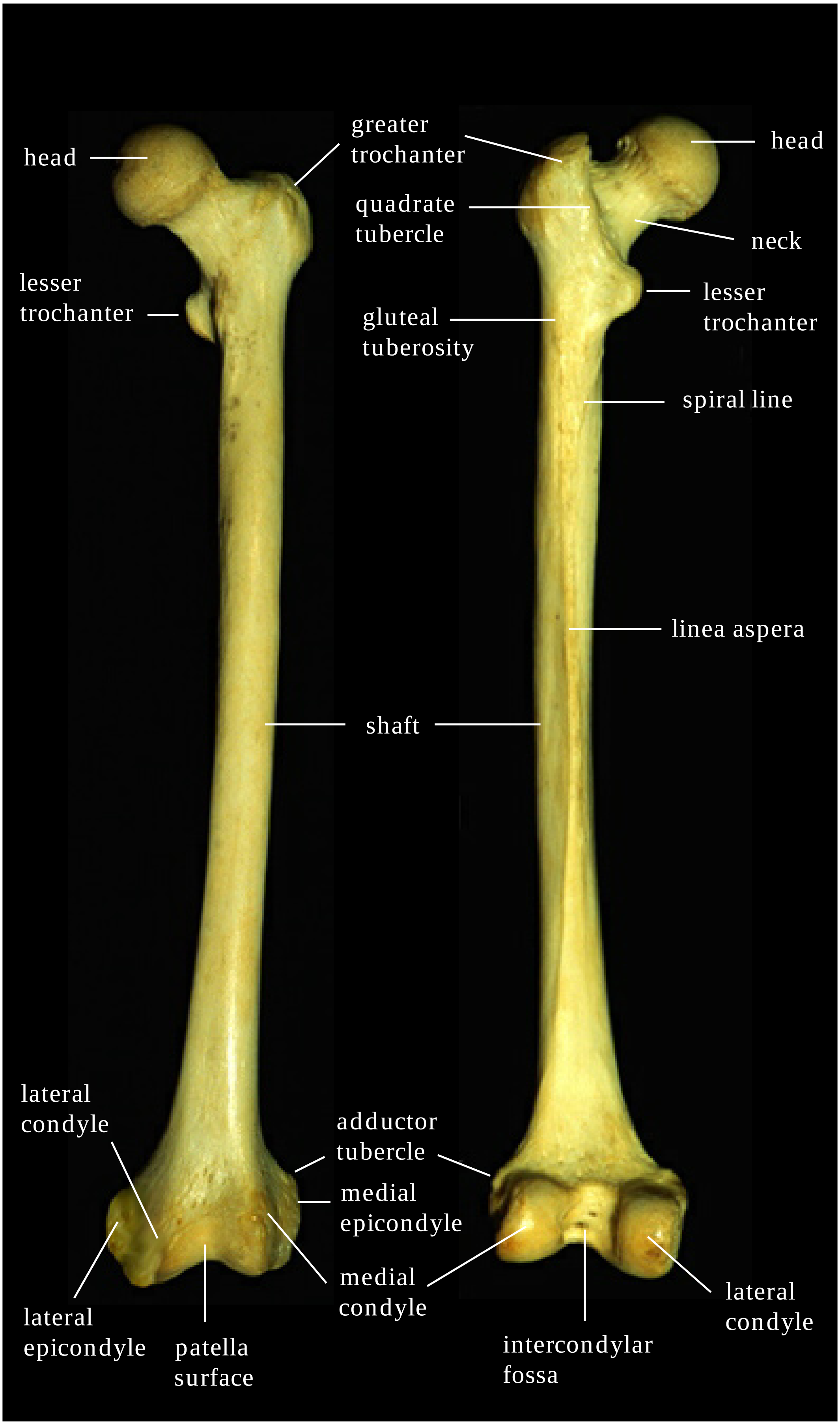


Figure 50. Left femur, anterior and posterior views.

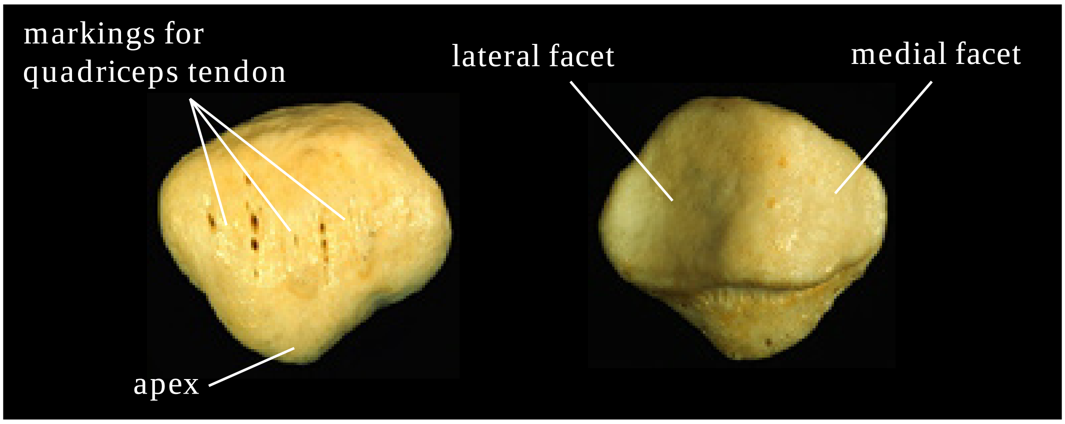


Figure 51. Left patella, anterior and posterior views.

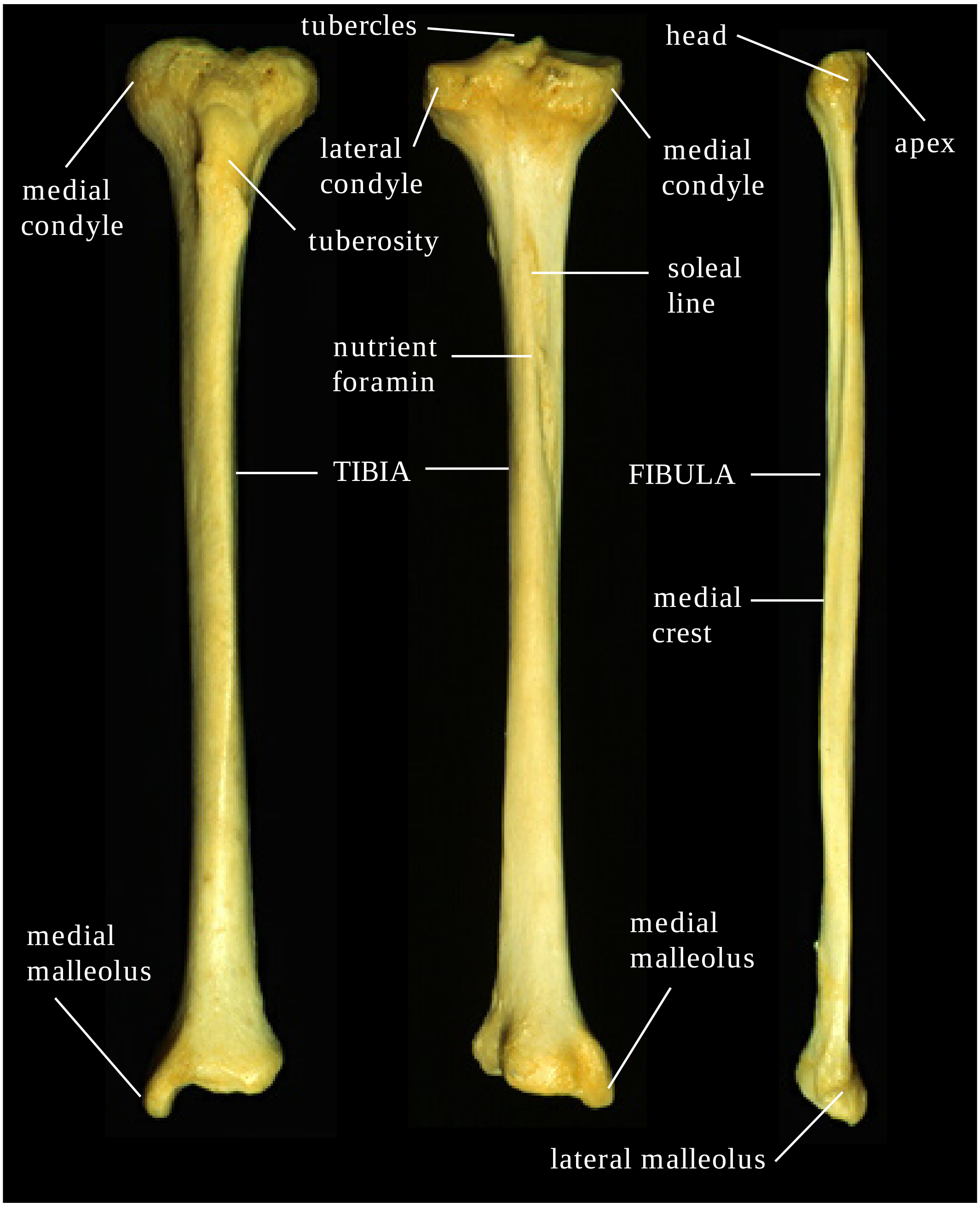


Figure 52. Left tibia, anterior and posterior views and left fibula, anterior view.

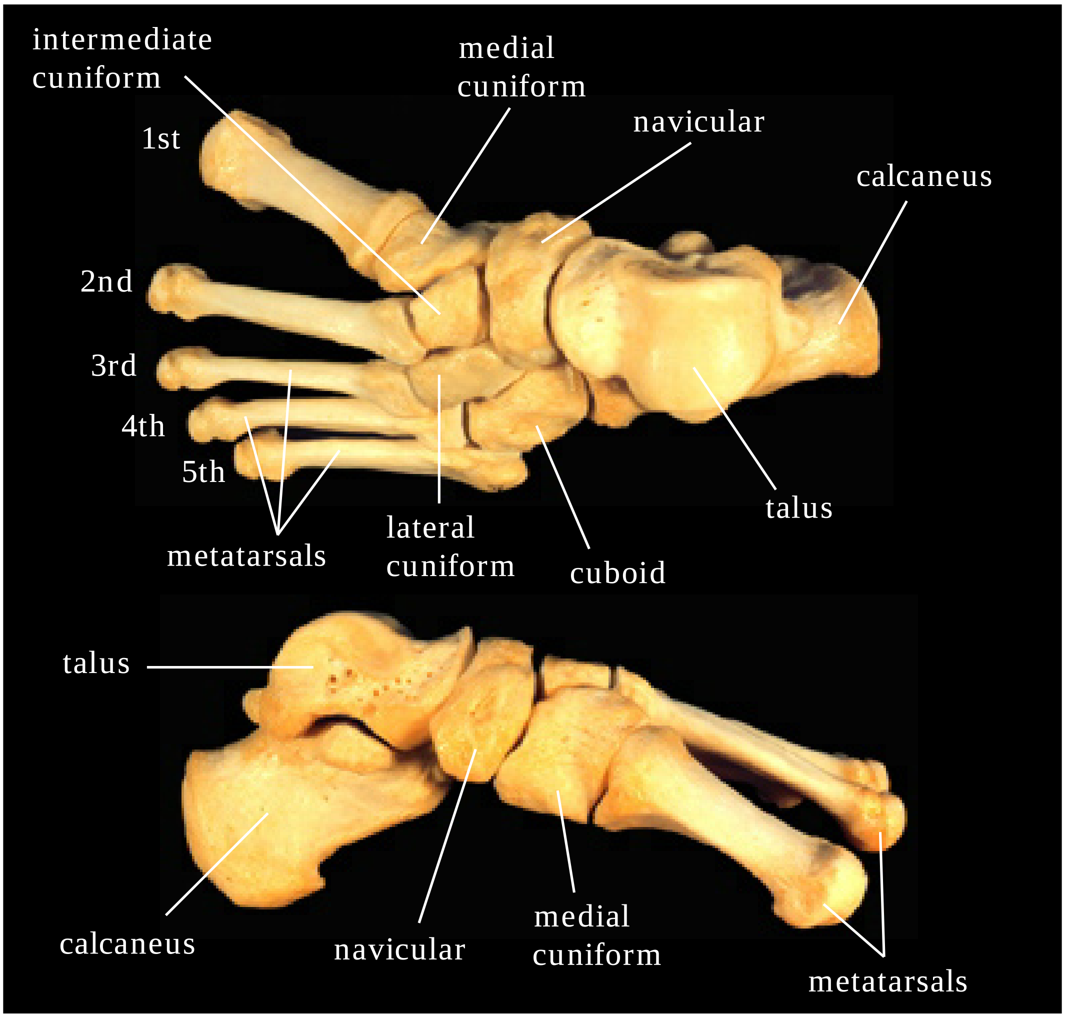


Figure 53. Superior and medial views of the tarsal and metatarsal bones of the left foot.

Figure 54. Superior view of the phalanges for the first and second toes.

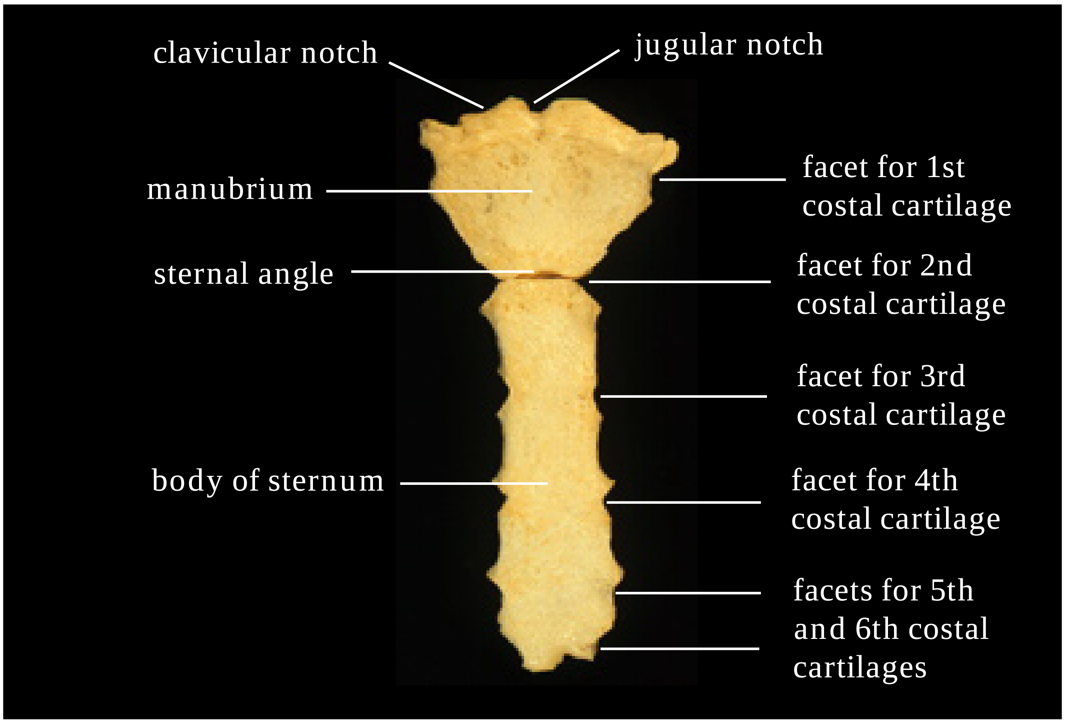


Figure 55. The sternum, anterior or ventral view.

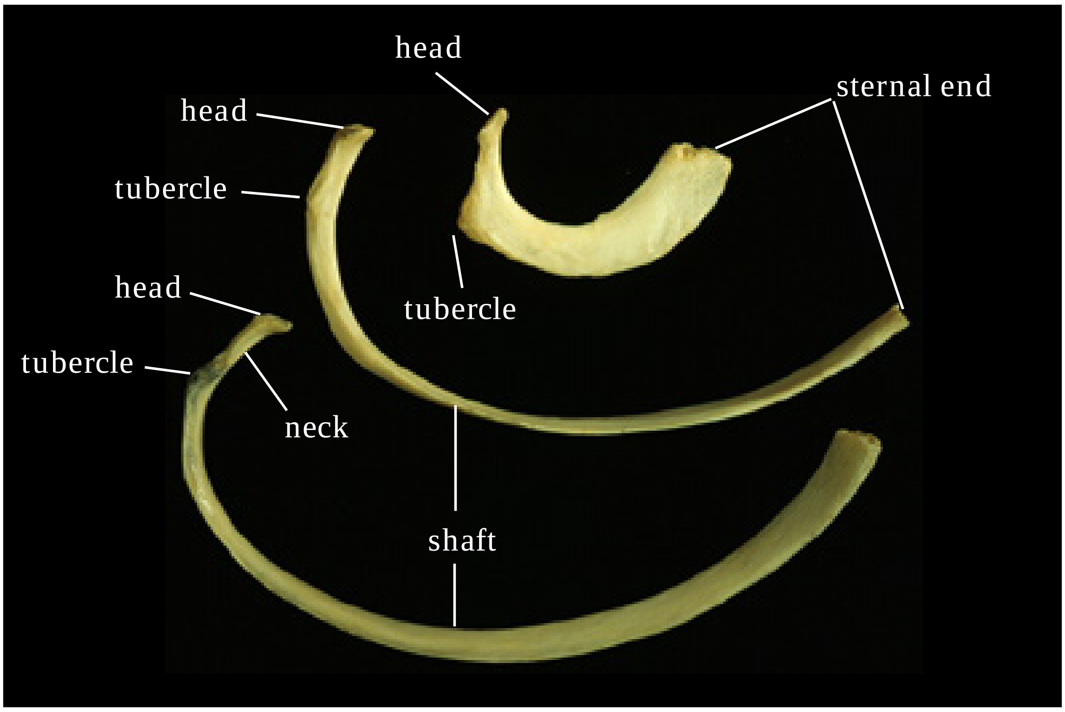


Figure 56. First, fourth and seventh ribs, inferior view.