ANTHROPOLOGIC LANDMARKS
OF THE SKULL
MEASUREMENTS AND INDICES

April 28, 2010

THE CALVARIUM

1. **Glabella:** Most prominent point of the forehead, which occurs in the anterior midline at the lower margin of the frontal bone. This lies above the nasal root and between the superciliary arches. The point of the glabella is depressed between the confining bony ridges, and is often delineated superiorly by a shallow gutter or a transversely running indentation on the surface of the frontal bone. It is important to remember in juvenile skulls, which have strongly forwardly vaulted foreheads, the most projecting point of the curve of the forehead is not that of glabella.
2. **Bregma:** Point of juncture of the left and right coronal sutures and the superior sagittal suture. Bregma can be very difficult to determine in the calvarium of children with open fontanelles, skulls with, "Fontanelle" bones, and in skulls with total obliteration of the sutures. In the latter case it may be possible to see existing traces of the sutures by slightly moistening the area. In the case of the presence of a "Fontanelle" bone, a straight extension of the sagittal suture is drawn across the forehead while a similar connection is drawn between the two sections of the coronal suture. Bregma is positioned at the point of the intersection of these two imaginary lines.

"Fontanelle" bones are accessory bones, which can occur in every fontanelle of the mammalian skull. These bones often have special names, which depend on the fontanelle they occur in. Of more common occurrence are the small bones which occur in the sutures, called Wormian bones, which are similar in origin to the "Fontanelle," bones and in principle are the same. Wormian and Fontanelle bones may be found in close association and it is sometimes impossible to determine, which bones belong to the fontanelle and which to the suture.

The bregmatic fontanelle bones are derived from accessory ossification centers in the anterior (bregmatic) fontanelle. These bones were first discovered in man in the

sixteenth century by the physician Paracelsus, who gave them the name “ossiculum anti-epilepticum,” believing them to be a remedy for epilepsy.

These bregmatic bones are very common in only a few mammals. In the large majority of mammalian skulls they are rarely seen and in some never seen.

3. **Vertex:** Highest point on the convexity of the calvarium measured from the Frankfurt plane (auriculo-orbital plane). The Frankfurt plane is a plane defined by a line passing through the inferior margin of the left orbit (a point called the left orbitale) and the upper most lateral margin of each ear canal referred to as the porion. This plane was established at the World Congress on Anthropology in Frankfurt, Germany in 1884. In normal individuals both orbits and porions are in the same plane, however, due to pathology this is not always the case. This formal definition specifies only these three points, which are sufficient to describe a plane in three-dimensional space.

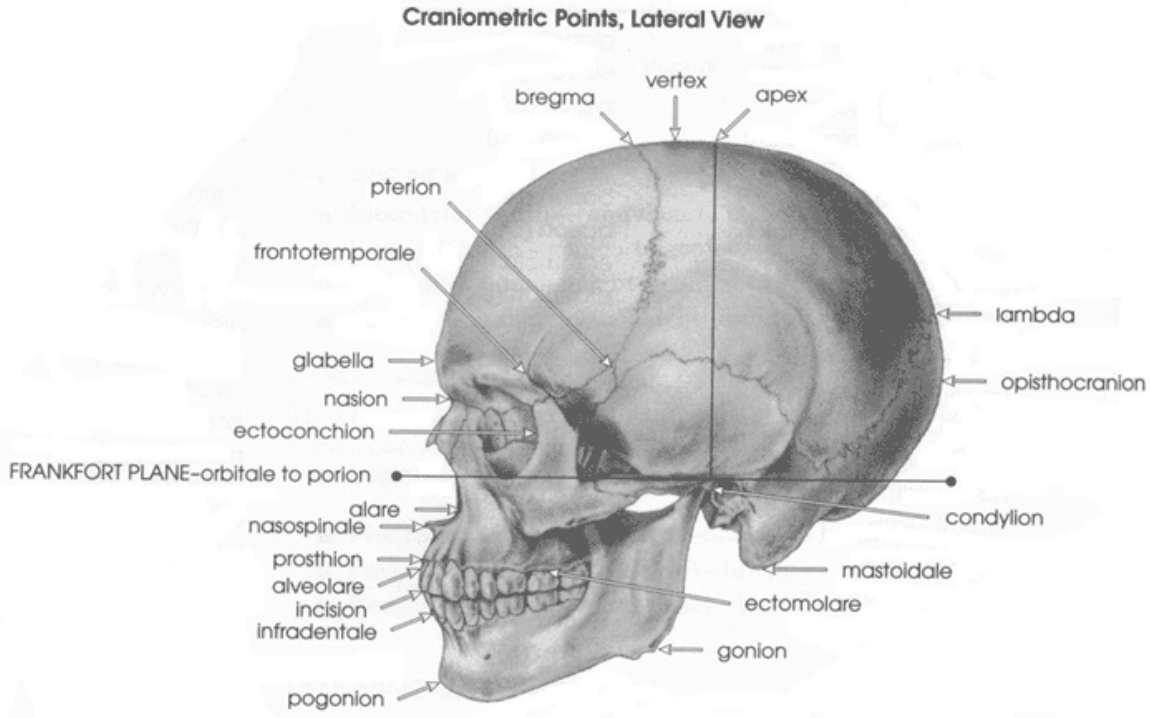
4. **Lambda:** Point of juncture of the left and right lambdoidal sutures and superior sagittal suture.

5. **Inion:** This is the most prominent point in the posterior aspect of the occipital calvarium (back of the head) occurring at the intersection of the left and right superior nuchal lines. It is at the base of the external occipital protuberance.

6. **Opisthocranion:** This is the most posteriorly protruding point on the back of the skull, located in the mid-sagittal plane. Opisthocranion almost always falls on the superior squama of the occipital bone, and only occasionally on the external occipital protuberance. The opisthocranion can generally be established while obtaining the measurement of maximum cranial length.

7. **Porion:** These are paired points at the lateral most part of the superior margin of the external auditory meatus. As previously pointed out, it is used to define the Frankfurt plane and to measure mastoid length.

8. **Asterion:** This is the point where the temporal, parietal and occipital bones meet. It is also referred to as the point of the skull corresponding to the posterior end of the parietomastoid suture.



BASE OF THE SKULL

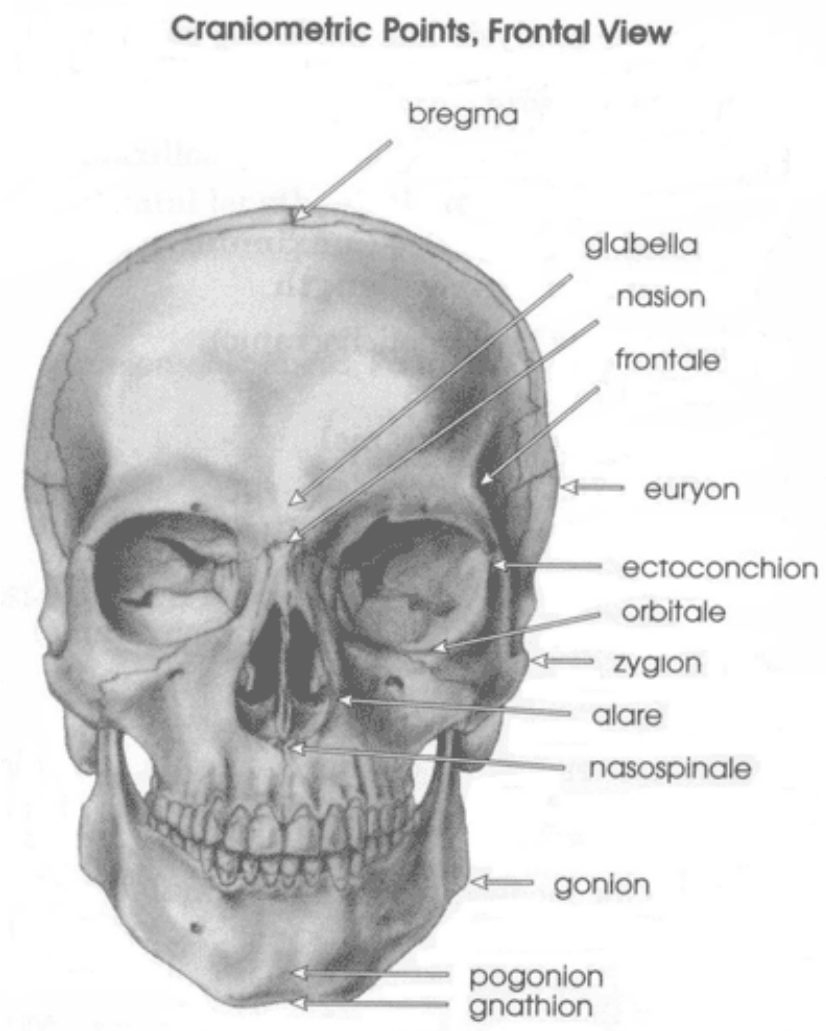
1. **Opisthion:** This is the midpoint of the posterior margin of the foramen magnum in the mid-sagittal plane. Opisthion is located on the inner border of the posterior margin of the foramen magnum facing basion.

2. **Basion:** This is the midpoint of the anterior margin of the foramen magnum in the mid-sagittal plane directly opposite of opisthion. In rare cases, the determination of the position of basion may be made difficult by a thickening of the anterior margin, In determination of the height of the skull, basion is positioned somewhat farther onto the underside of the margin of the foramen magnum.

3. **Staphylion:** This is a single point on the posterior hard palate where the palatal suture is crossed by a line drawn tangent to the curves of the posterior margin of the palatal bones. It is used to measure palatal length.

4. **Orale:** This is the most anterior point on the hard palate where a line drawn lingual to the central incisors intersects the palatal suture. It is used to measure palatal length.

6. Endomolare: This is the most medial point on the inner margin (lingual surface) of the socket of the second upper molar. It is used to measure palatal width.



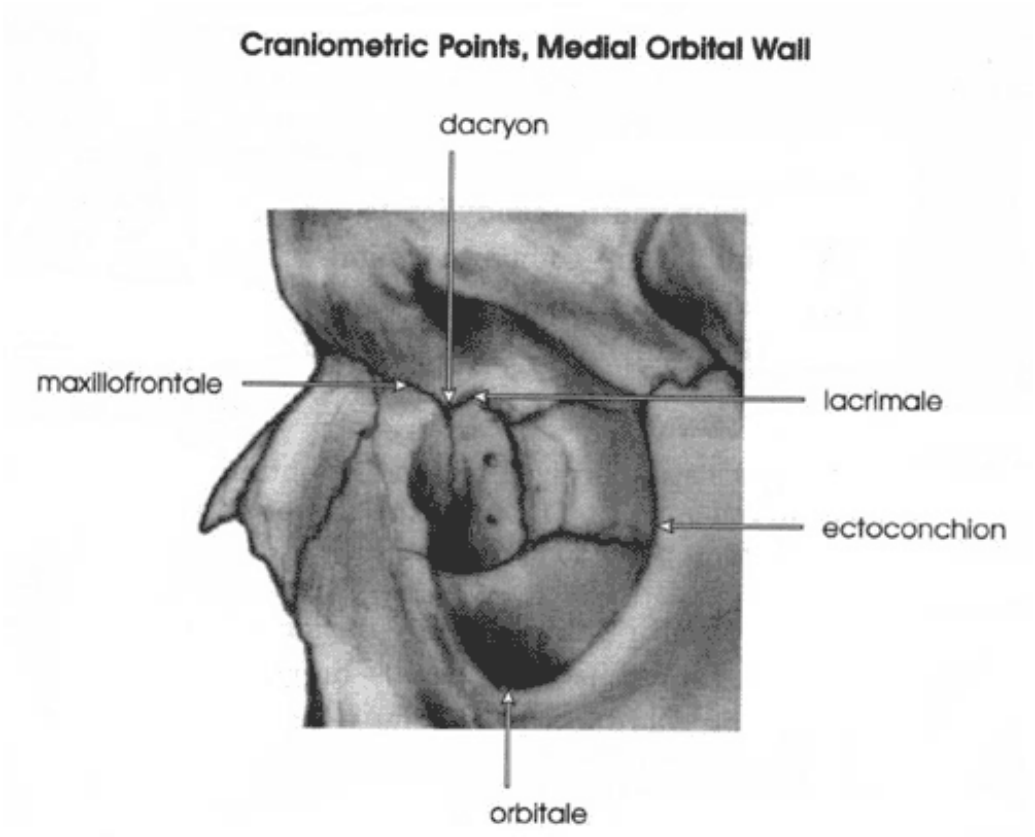
UPPER FACIAL SKELETON

1. **Prosthion:** The most anterior point on the alveolar border of the maxilla between the central incisors in the mid-sagittal plane. Note that in measuring basion-prosthion length and palate length, prosthion is not positioned on the inferior margin of the advanced bony parts between the incisors, but is more anteriorly located on the anterior surface of the alveolar process. In measuring upper facial height, however, prosthion is located on the inferior tip of the alveolar process. If the alveolar process has been absorbed or is defective, determination of upper facial height is virtually impossible.

2. **Nasospinale:** This is the lowest point on the inferior margin of the nasal aperture in the the mid-sagittal plane on a line drawn between the ala nasi at the base of the nasal spine.

3. **Nasion:** This is the midpoint of the sutures of the frontal and nasal bones or the point of intersection of the nasofrontal suture in the anterior-midline (mid-sagittal plane).

4. **Dacryon:** This is the midpoint of the sutures of the frontal, maxillary and lacrimal bones, which occurs on the medial border of the orbit. Dacryon is also referred to as



the point of intersection of the lacrimomaxillary suture and the frontal bone. There is often a small foramen at this point.

THE MANDIBLE

1. **Gnathion:** This is the midpoint on the lower border of the mandible in the mid-sagittal plane. It is not uncommon to find that gnathion is not the most inferiorly located point of the mandible, as the more laterally placed elements of the mandible may be extending far more inferiorly. This is especially the case in mandibles with broad and square chin development.

2. **Gonion:** This is the most lateral point on the angle made by the body and ascending ramus. To phrase this another way, it is the point on the mandible where the inferior margin of the mandibular corpus and the posterior margin of the ramus meet, i.e. the point on the mandibular angle, which is directed most inferiorly, posteriorly, and laterally. When measuring the bi-gonial diameter, the most lateral position of the angles should be chosen as measuring points.

3. **Infradentale:** This is the point between the lower incisor teeth where the anterior margins of the alveolar processes are intersected by the mid-sagittal plane. This point corresponds to the antero-superior limit of the fetal symphyseal suture.

4. **Pogonion:** This is the most anterior point on the chin in the midline. To phrase this another way, it is the most forward-projecting point on the anterior surface of the chin.

MEASUREMENT OF THE SKULL'S VOLUME

1. **Mathematical Method:** To accomplish skull volume using the mathematical method you need the length, width and height of the skull. In measuring the height you can us either the basion or porion. We will utilize the formulas of Pearson:

When the height is taken from basion:

Males: 524.6 + (0.000266 x length x breadth x height)

Females: 812.0 + (0.000156 x length x breadth x height)

When the height is taken from porion:

Males: 359.35 + (0.000365 x length x breadth x height)

Females: 296.40 + (0.000400 x length x breadth x height)

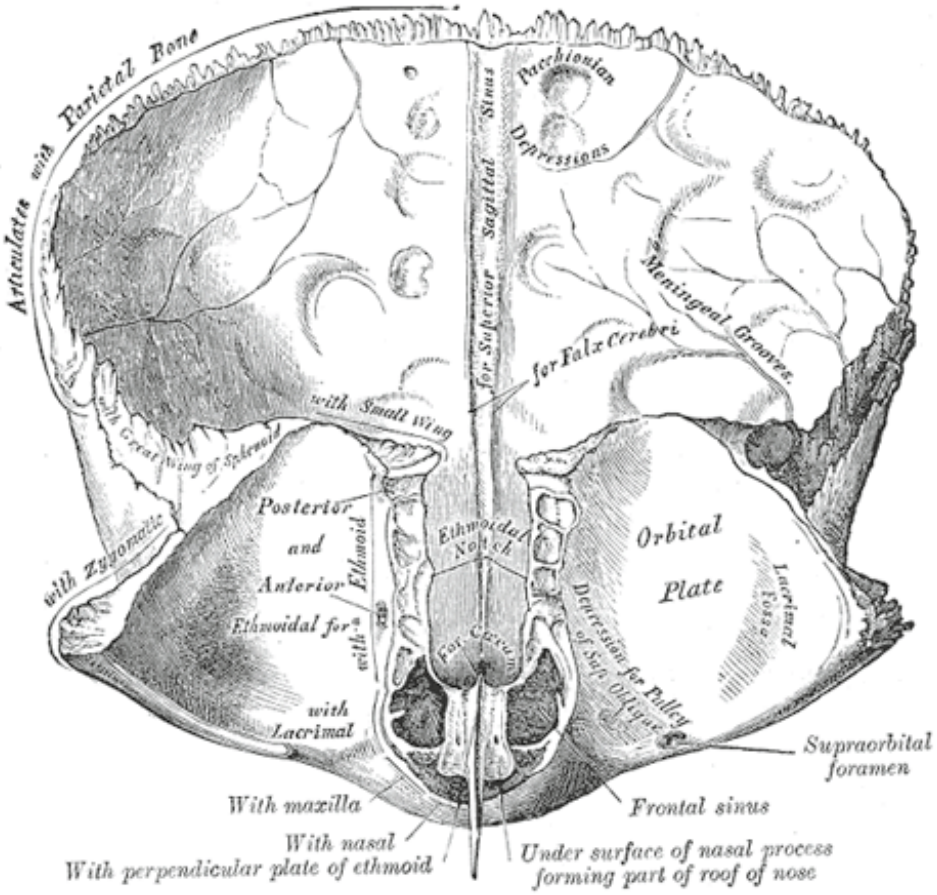
Cranial length: From glabella to opisthocranium

Cranial breadth: Maximum transverse diameter

Cranial height (1): From basion to bregma

(2): From porion to bregma

Minimal Frontal Diameter: Minimum diameter on frontal crests. The internal surface of the squamosal portions of the frontal bone have a vertical groove in the midline of the convexity, which is referred to as the sagittal sulcus, the edges of which unite below to form a ridge called the frontal crest. It is the margins of the sagittal sulcus and the frontal crests, which afford attachment of the falx cerebri.



Bizygomatic Diameter: Maximum diameter between zygomatic arches.

Bi-postorbital Diameter: Minimum diameter taken across the post-orbital constrictions, generally at the level and behind the fronto-zygomatic suture.

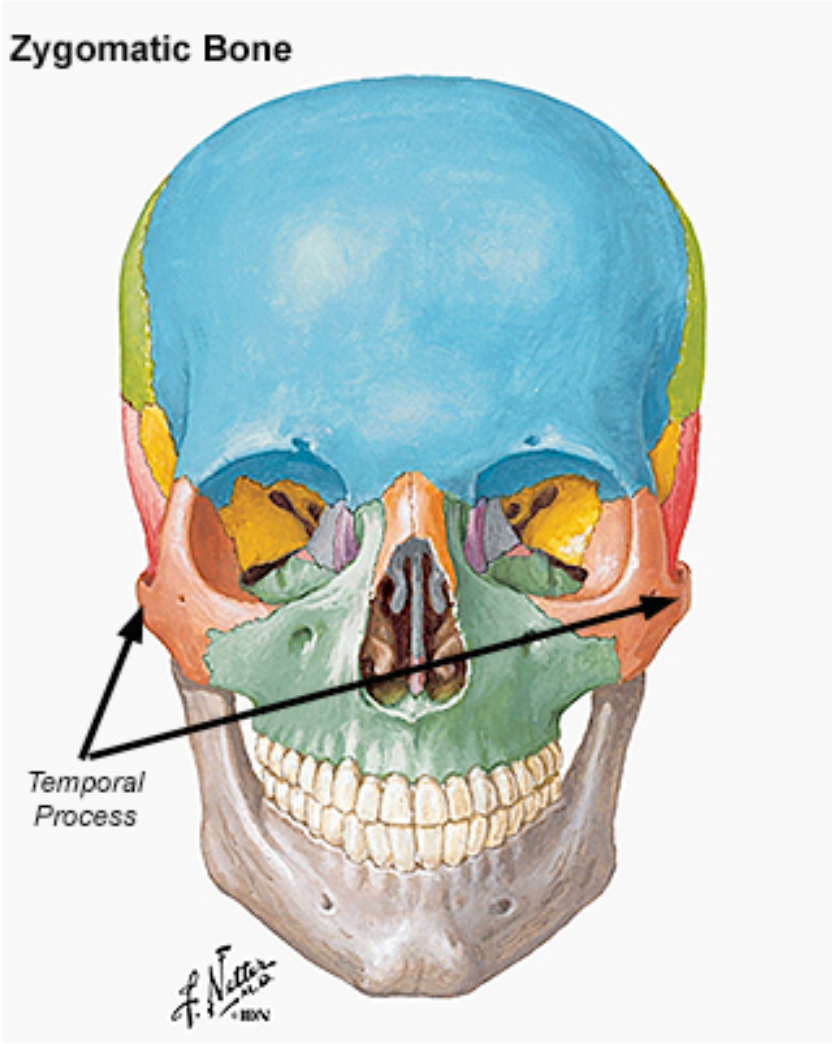
Upper Facial Height: From the nasion to prosthion.

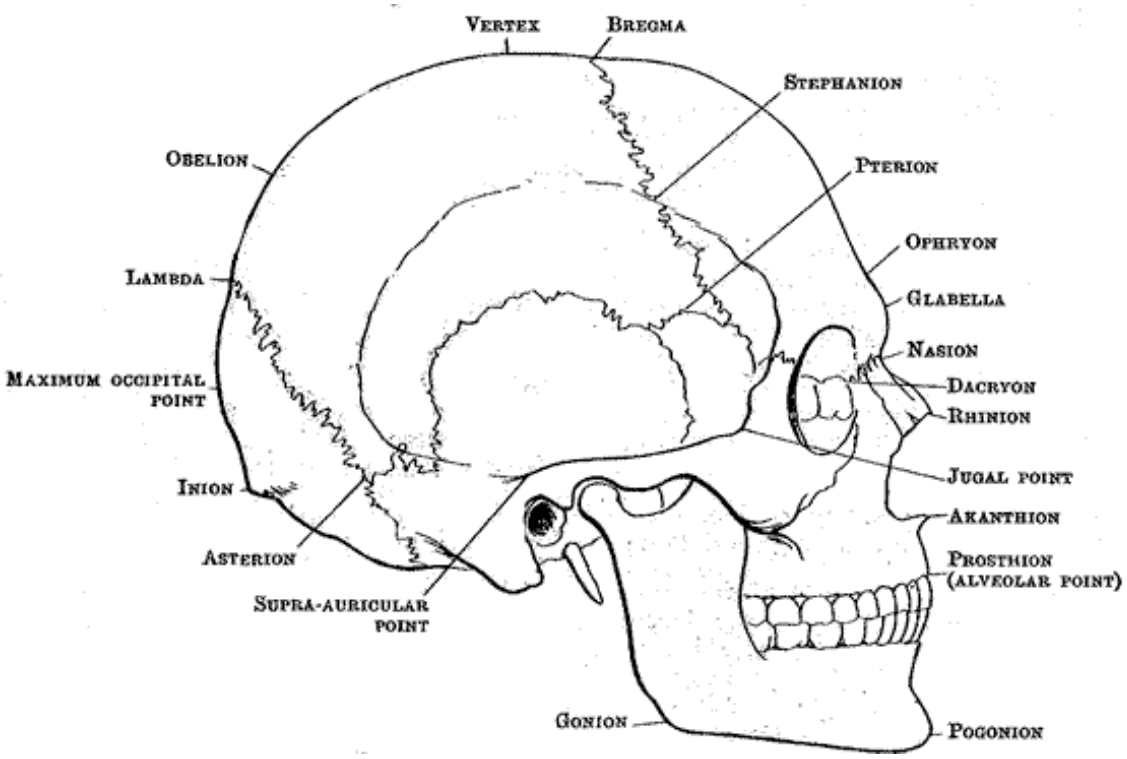
Total Facial Height: From nasion to gnathion.

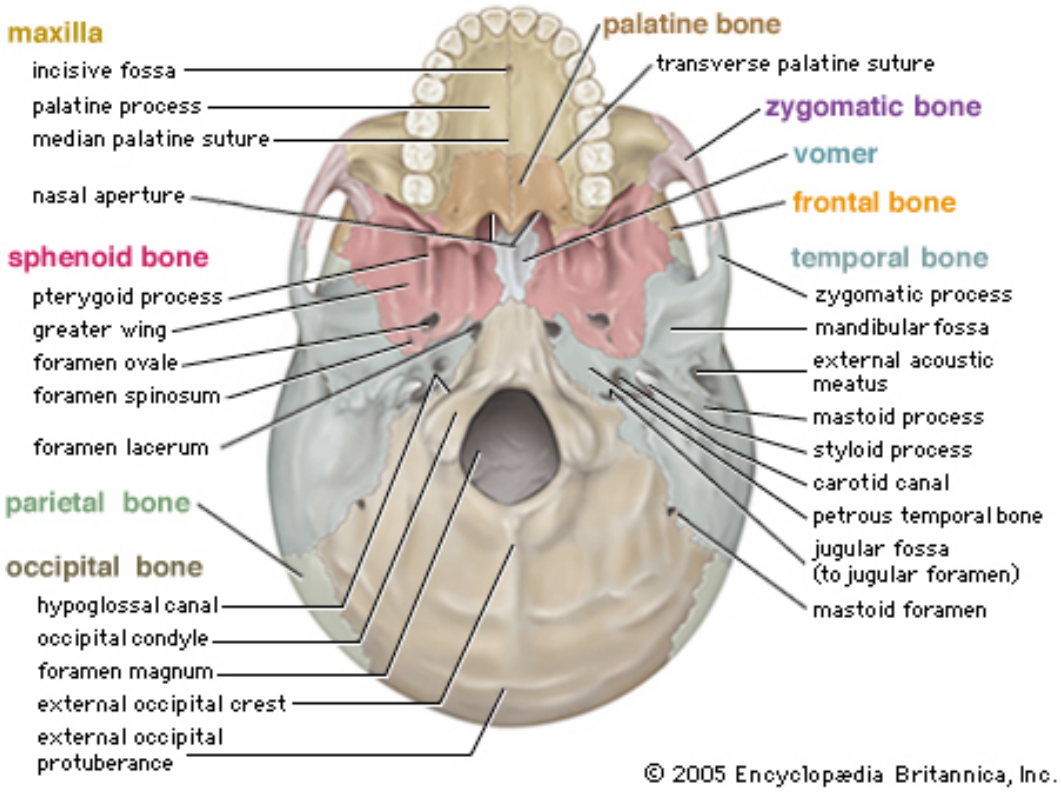
Nasal Height: From nasion to nasospinale.

Nasal Breadth: Maximum breadth of nasal cavity.

Inter-orbital Breadth: Distance between the dacryons.

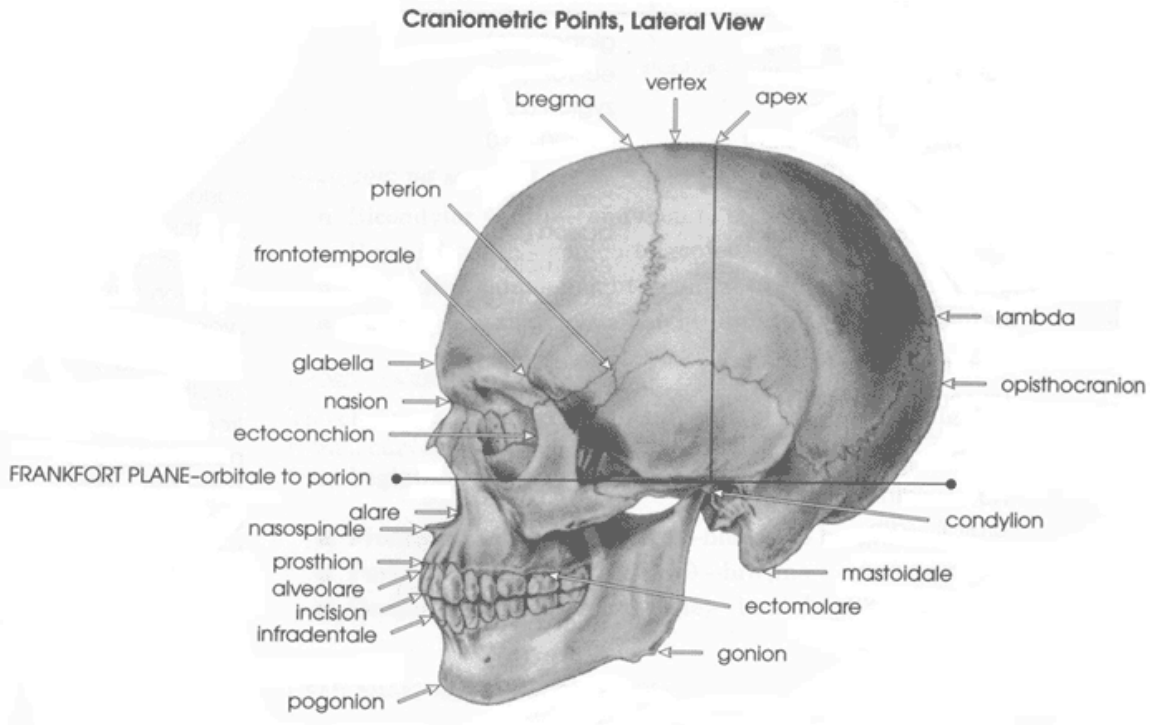

Zygomatic Bone
Temporal Process


VERTEX
BREGMA
STEPHANION
OBELION
PTERION
OPHRYON
LAMBDA
GLABELLA
NASION
MAXIMUM OCCIPITAL POINT
DACRYON
RHINION
JUGAL POINT
INION
AKANTHION
ASTERION
PROSTHION (ALVEOLAR POINT)
SUPRA-AURICULAR POINT
GONION
POGONION



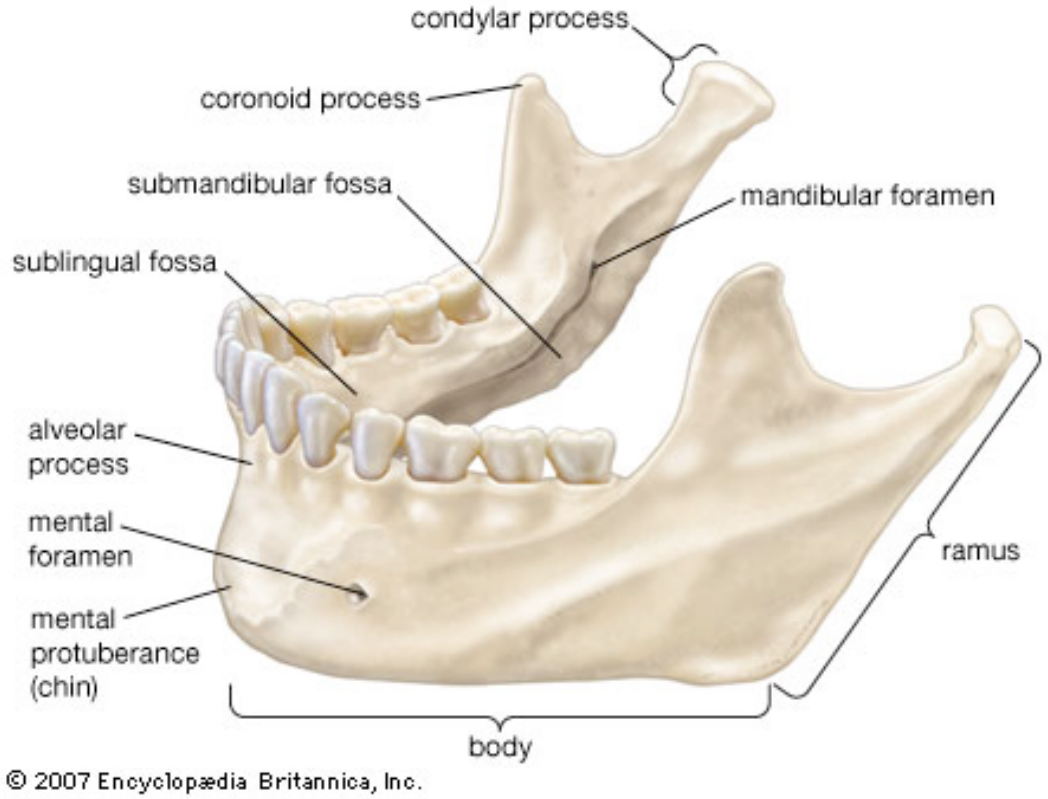
Palatal Length: Distance from orale to staphylion.

Palatal Breadth: Distance between the endomolare.



Maximum Cranial Circumference: Measure this distance by using flexable tape that is placed around the skull using the glabella as the anterior point and the opisthocranion as your posterior point.

Mandibular Measurements:



Bicondylar Width: This is the diameter between the lateral points on the condyles.
Bigonial Diameter: This is the diameter between the two gonions.
Height of Ascending Ramus: This is the distance from ganion to the most superior point on the condyle.
Minimum Breadth of Ascending Ramus: This is the minimum distance across the ramus.

INDICES OF THE SKULL

1. Cephalic Index: cranial breadth/cranial length x 100
2. Height-Length Index: cranial height/cranial length x 100
3. Height-Breadth Index: cranial height/cranial breadth x 100
4. Fronto-Parietal Index: minimum frontal/cranial breadth x 100
5. Cranio-Facial Index: bizygomatic/cranial breadth x 100
6. Charney Index: bi-posorbital/bizygomatic x 100
7. Upper Facial Index: upper facial Height/bizygomatic x 100
8. Total Facial Index: total facial height/bizygomatic x 100
9. Nasal Index: nasal breadth/nasal height x 100
10. Palatal Index: palatal breadth/palatal lenght x 100

Examples of Ranges of the Indices and what they mean:

1. Cephalic Index: up to 75 mm (narrow or long headed).....Dolichocephalic

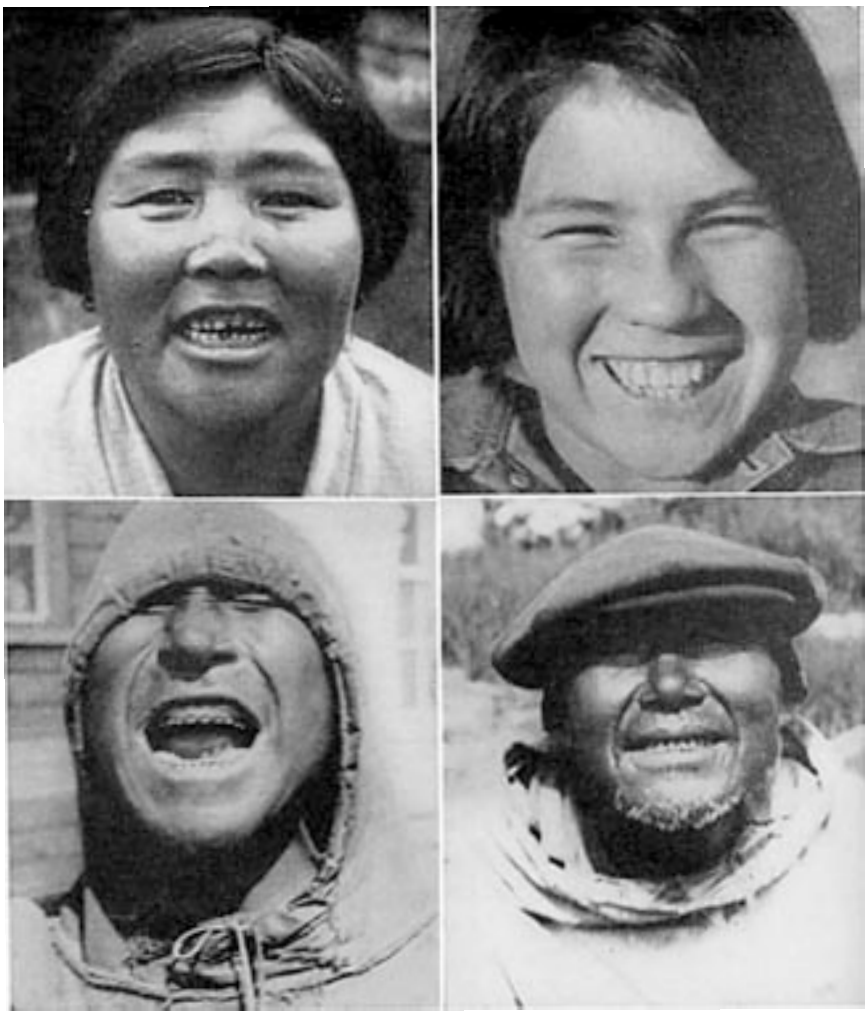
75.0 to 79.9 (average or medium).....Mesocephalic

80.0 to 84.9 (round headed).....Brachycephalic

85.0 and up (like a squash).....Hyperbrachycephalic

2. Facia Index (Upper): up to 44.9 mm (very broad face).....Hypereuryeny

45.0 to 49.9 (broad face).....Euryeny



50.0 to 54.9 (average or medium)....Meseny

55.0 to 59.9 (narrow face).....Lepteny

60.0 and up (very narrow face).....Hyperlenteny

2. Nasal Index: up to 47.9 (narrow aperture).....Leptorrhiny
48.0 to 52.9 (average or medium)....Mesorrhiny
53.0 and up (broad aperture).....Platyrrhiny

In the above illustrations, leptorrhiny (leptorrhine) is represented on the left, mesorrhiny (mesorrhine) is in the middle and platyrrhiny (platyrrhine) is on the right.

MEASUREMENTS OF THE SACRUM

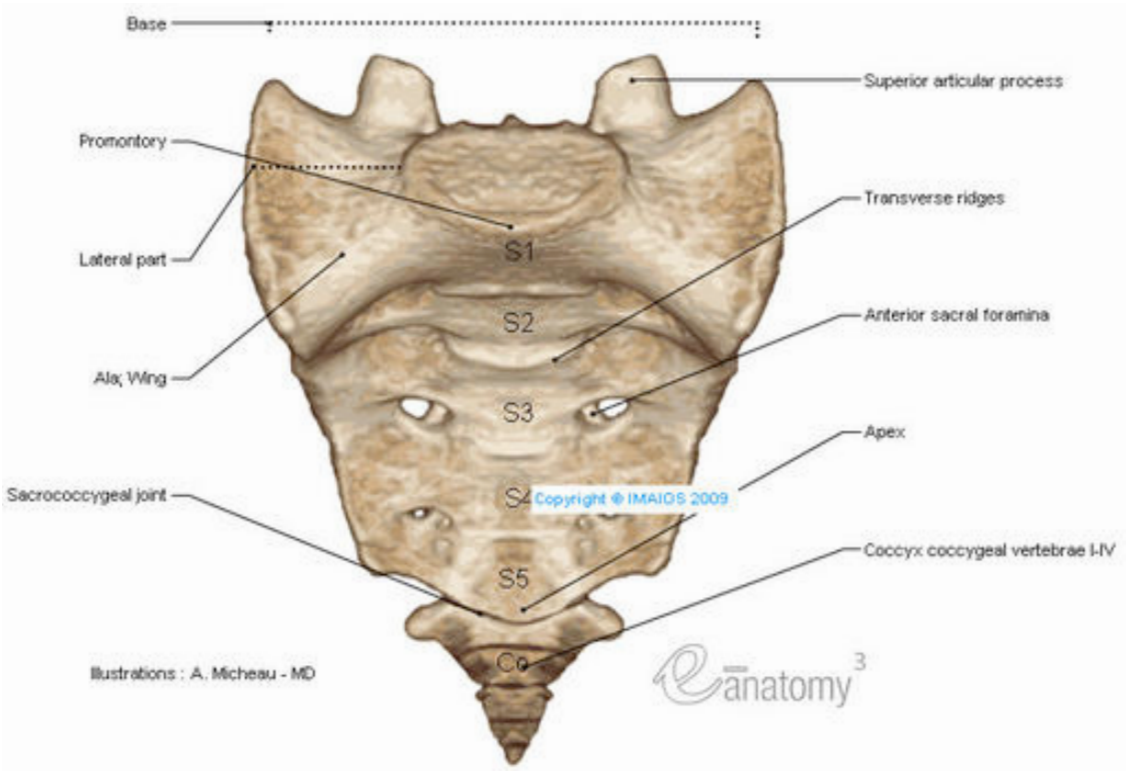
1. Height: The height of the sacrum is the distance from the anterior lip of the promontory in the mid-sagittal plane, to the antero-inferior border of the last sacral vertebra. When determining the height of the sacrum use only those sacra with five segments.
2. Width: This is the greatest diameter between the wing (alae) of the first sacral segment.
3. Length: This is the curved length measured with flexible tape from the anterior lip of the promontory in the mid-sagittal plane to the antero-inferior border of the last sacral vertebra.

Indices of the Sacrum

1. Sacral Index: width/height x 100
2. Curvature Index: height/curved height x 100

3. The Sacral Index in different populations (Wilder 1920118):

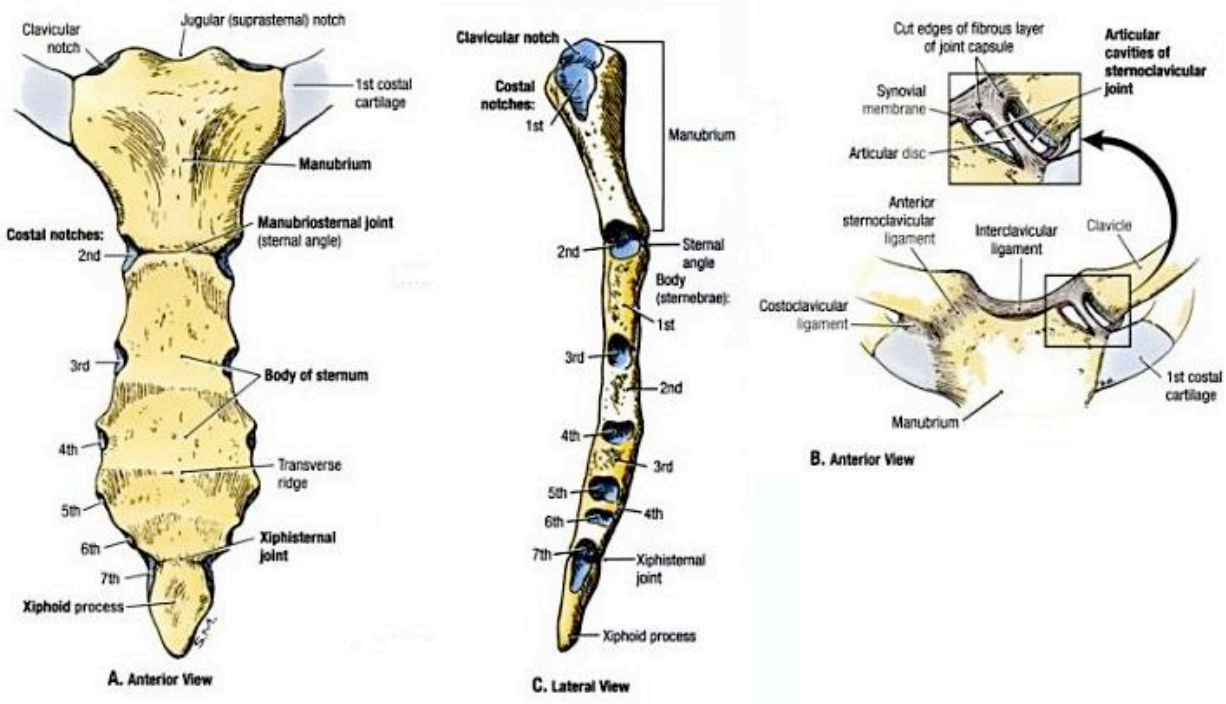
	Males	Females
Blacks	91.4	103.6
Egyptians	94.3	99.1
Australians	94.8	110.0
Japanese	101.5	107.1
Europeans	102.9	112.4



MEASUREMENTS OF THE STERNUM

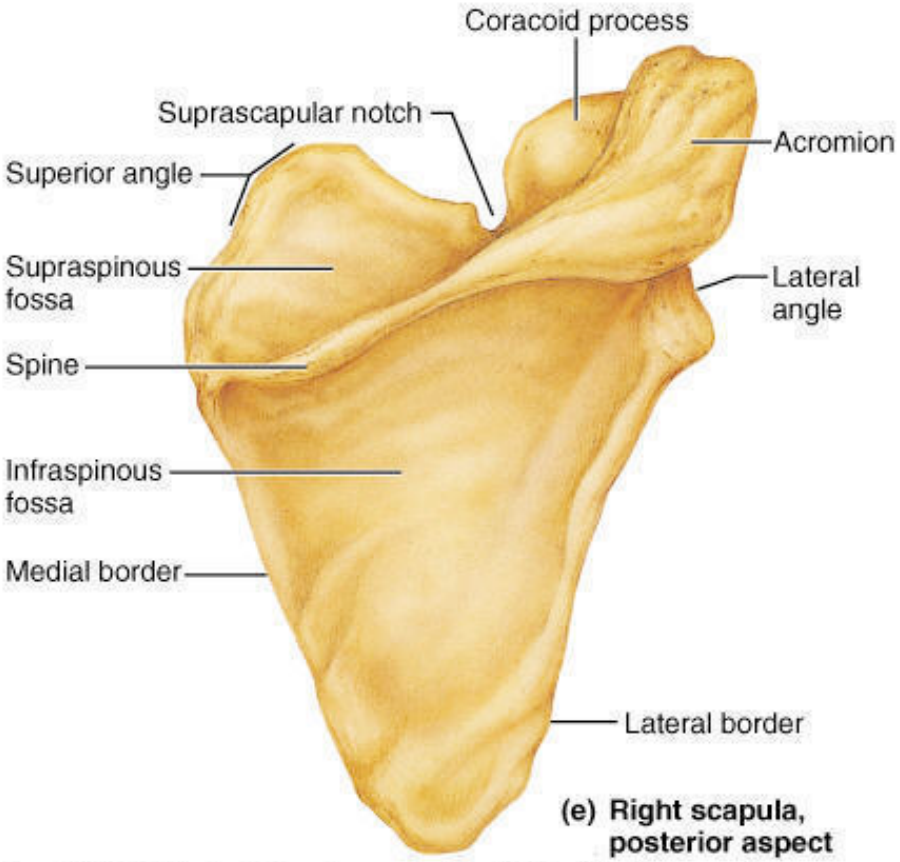
1. Manubrium: length of
2. Body: length of

In general, the length of the body of the sternum is more than twice the length of the manubrium, in males. It is less in females, that is, less than twice the length.



MEASUREMENTS OF THE SCAPULA

1. Total length: Superior angle to inferior angle.
2. Total breadth: This is from the margin of the glenoid fossa to the base of the spine on the vertebral border.
3. Height of supraspinous fossa: This is from the superior angle to the base of the spine on vertebral border.
4. Height of infraspinous fossa: This is from the inferior angle to the base of the spine on the vertebral border.



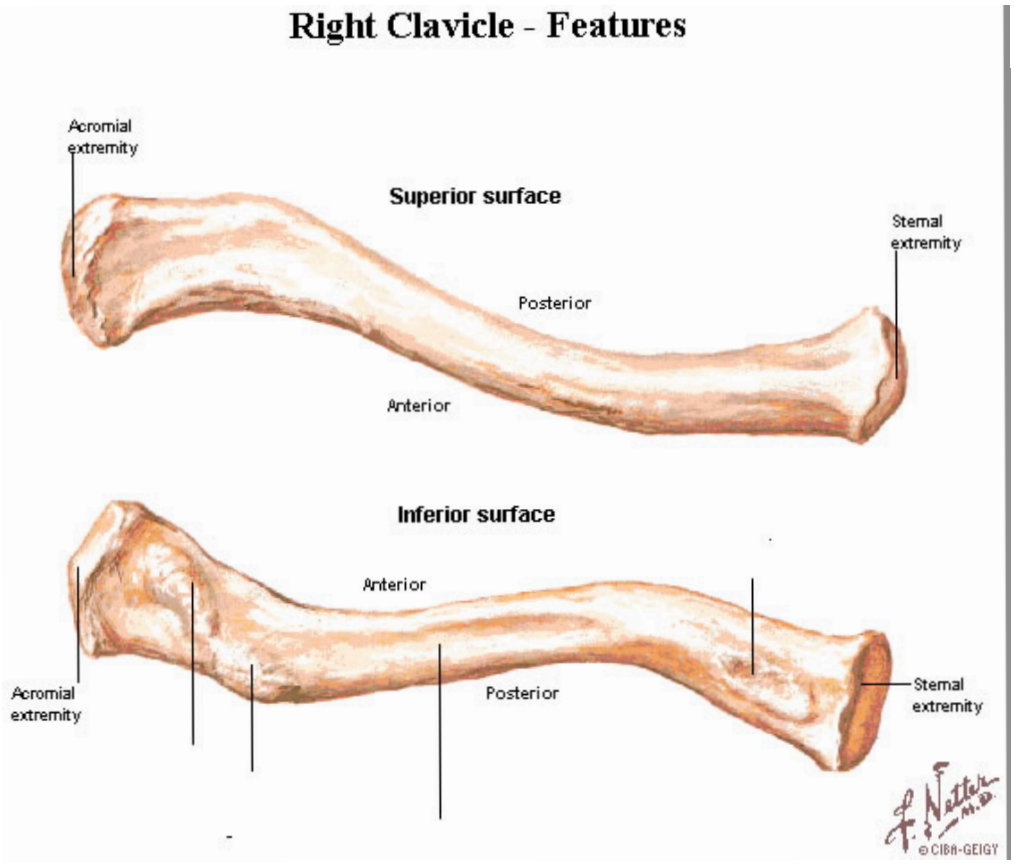
Indices of the Scapula

1. Scapula index: breadth x 100/total length
2. Supraspinous index: height of supraspinous fossa x 100/total breadth
3. Infraspinous index: infraspinous height x 100/total breadth

MEASUREMENT OF THE CLAVICLE

1. Total length: measured from lateral to medial ends

acromial extremity is the lateral end and the sternal extremity is the medial.

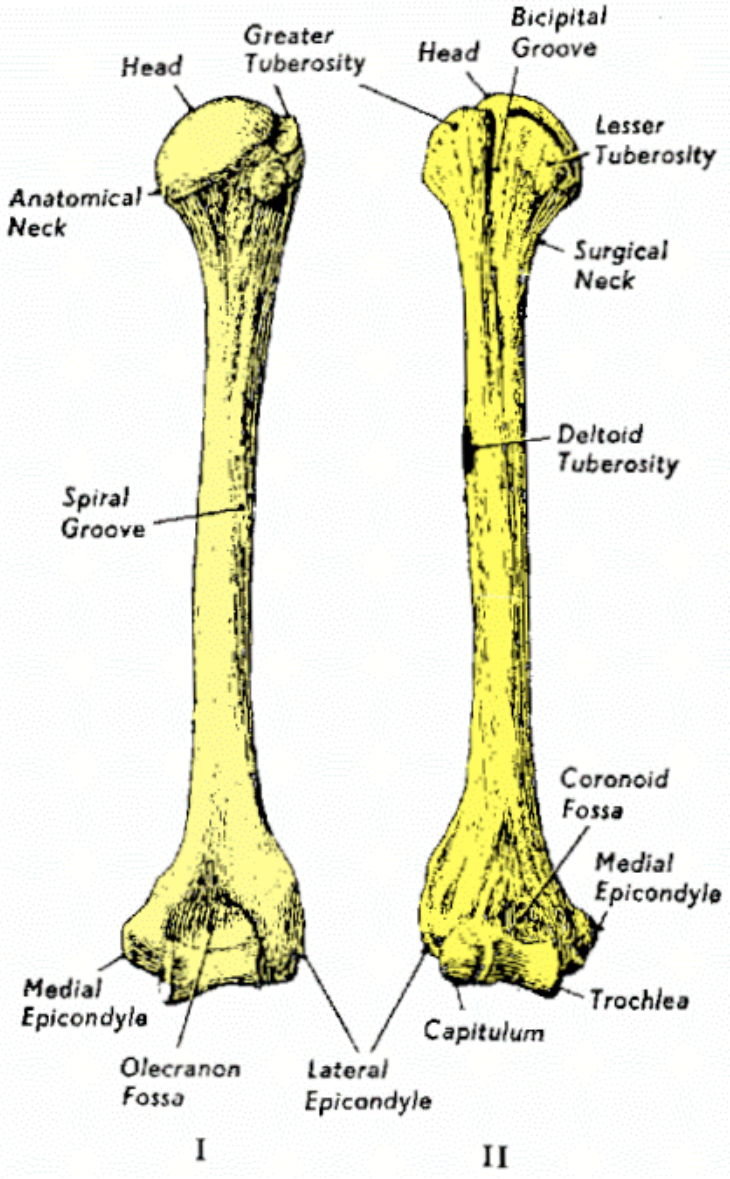


MEASUREMENTS OF THE HUMERUS

1. Total length: total distance from head to most distal point on lower end, measured parallel to shaft.
2. Head diameter: greatest diameter on head wherever found.
3. Proximal end breadth: greatest diameter in a plane perpendicular to shaft.
4. Distal end breadth: greatest distance between the epicondyles.

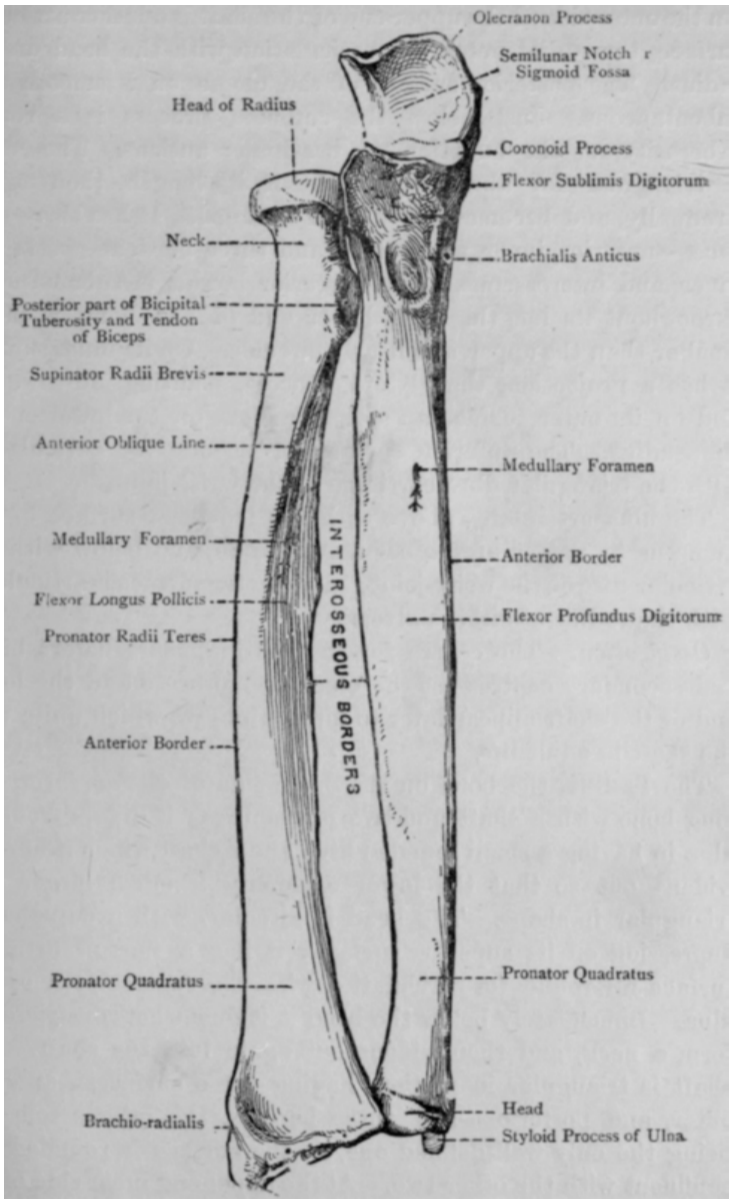
Indices of the Humerus

1. Humerus head index: proximal end breadth/humerus length
2. Distal end index: distal end breadth/humerus length



MEASUREMENTS OF THE ULNA

1. Maximum length: measured from the top of the olecranon process to the base of the styloid process.
2. Ulna shaft length: measured from the anterior part of the coronoid process to the inferior surface of the ulnar head.
3. Torchlear notch height: This is the distance between superior and inferior margins of the notch. Usually from the most anterior projection of the olecranon process to the most anterior projection of the coronoid process.



Measurements of the Radius

1. Maximum Length: measured from top to bottom.

2. Head diameter: maximum diameter on the head in a plane perpendicular to the shaft.

3. Distal end breadth: maximum diameter between the styloid process and the medial surface of the bone, in a plane perpendicular to the shaft.

Measurements of the Innominate

1. Height: measured from the ischial tuberosity to vertex of iliac crest.

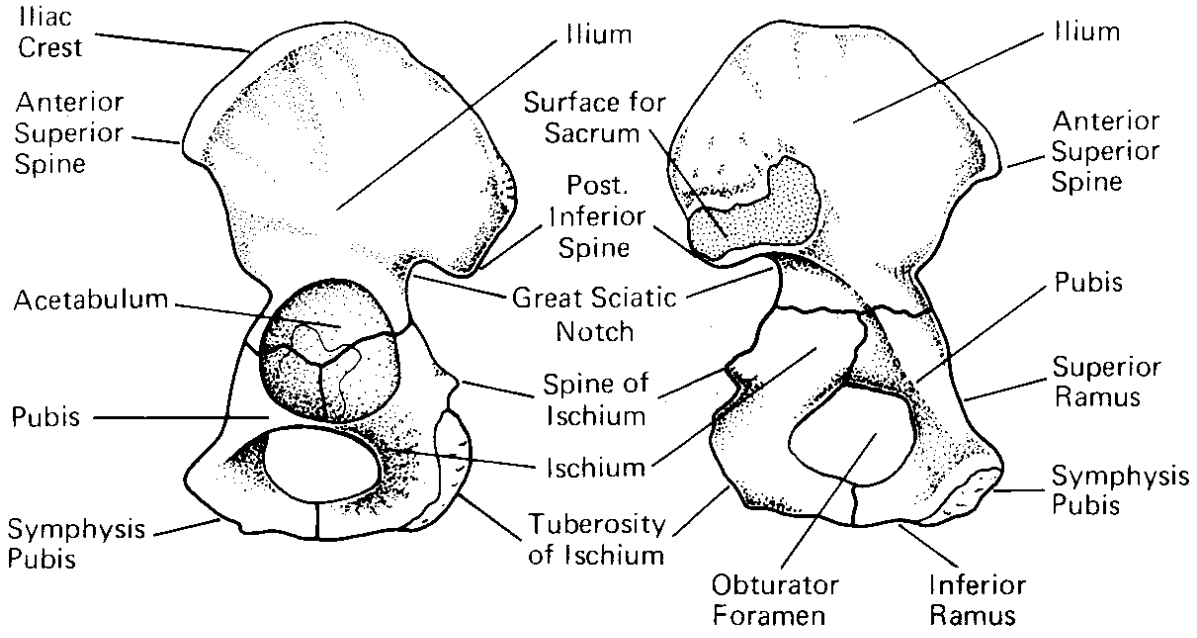
2. Breadth: measured from the anterior to posterior superior iliac spines.

3. Ischial length: measured from the tripoint in the acetabulum to the end of the ischium.

4. Pubic length: measured from the tripoint in the acetabulum to the end of the pubis. The tripoint of the acetabulum is where the three bones of the innominate (ischium, ilieum and pubic bones) meet. It is the point on the inner articular margin, nearest to the anterior superior iliac spine.

5. Subpubic angle: place the pubic symphyseal face against a straight line and trace the lower border or the inferior pubic ramus. Determine the angle with a protractor and then double the value. The other way to describe this is the angle made by tangents to the inferior ramus of each pubis, converging at the point defining the center of the pubic symphysis.

6. Angle of greater sciatic notch: place the innominate on paper; trace the borders of the greater sciatic notch then draw lines tangent to the borders after which you measure the angle.



The left innominate bone. External (*left*) and internal surfaces.

Measurements of the Femur

1. Maximum length: total length from one end to the other, parallel to the long axis of the bone.

2. Bicondylar breadth: this is the maximum transverse diameter across the condylar end of the femur at right angles to the long axis of the shaft.

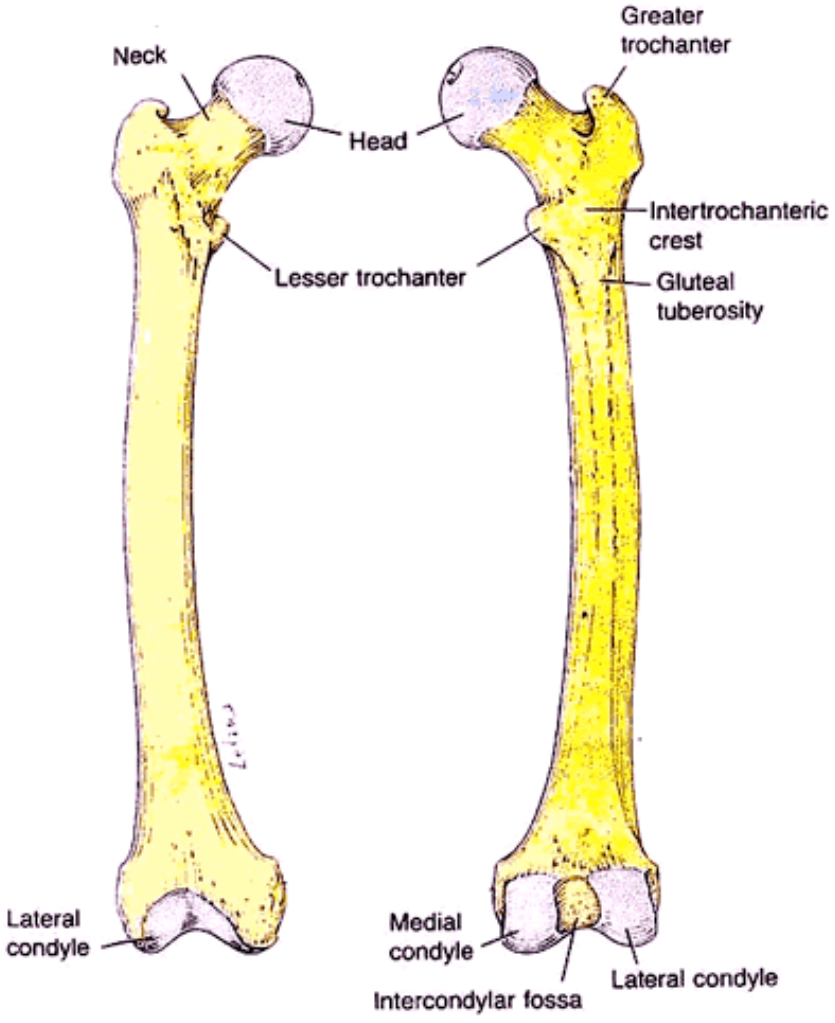
3. Diameter of the head: this is the maximum diameter.

4. Epicondylar width: this is the maximum diameter from medial to lateral epicondyles.

5. Mid transverse diameter: this is the maximum transverse diameter of the shaft at its mid level, at right angles to the long axis of the shaft.

6. Subtrochanteric transverse diameter: maximum transverse diameter of the shaft, just below the lesser trochanter, at right angles to the long axis of the shaft.

7. Subtrochanteric sagittal diameter (anterior-posterior): measurement below the lesser trochanter in the sagittal plane.



8. Collo-diaphyseal angle: this is the angle formed by the intersection of a line representing the long axis of the shaft and a line representing the axis of the neck and head.

Indices of the femur

The subtochanteric diameters may be employed in a ratio:
subtrochanteric sagittal diameter/subtrochanteric transverse diameter x 100 which gives you the platymeric index with values as follows:

Platymeric - up to 84.9% (flattened femur laterally)

Eurymeric - 85 to 99.9% (broad femur)

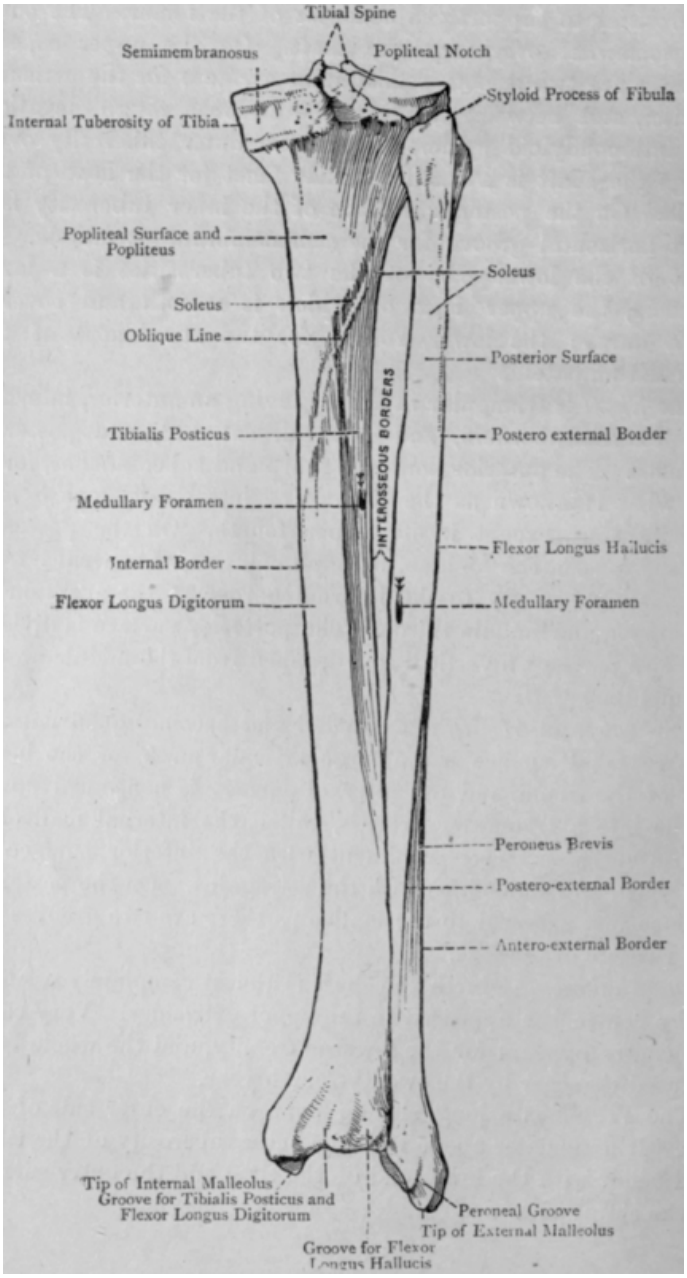
Stenomeric - 100% and above (rounded femur - usually found in pathological cases)

Measurements of the Tibia

1. Maximum morphological length: this is the total length measured from the intercondylar eminences to the tip of the medial malleolus, measured parallel to the shaft.

2. Due to the fact the tibia is a bone with variable shaft diameter, two diameters are taken at the level of the nutrient foramina, which is approximately a third of the way down from the upper end. These two measurements are:

    a. Transverse enemic diameter: maximum transverse diameter, at level of the nutrient foramen, taken at right angles to the long axis of the shaft.
    b. Sagittal enemic diameter (anterior-posterior): this is the maximum sagittal diameter, at the level of the nutrient foramen, at right angles to the shaft usually from the anterior crest.



In the above illustration the medullary foramen is another term for the nutrient foramen.

Indices of the Tibia

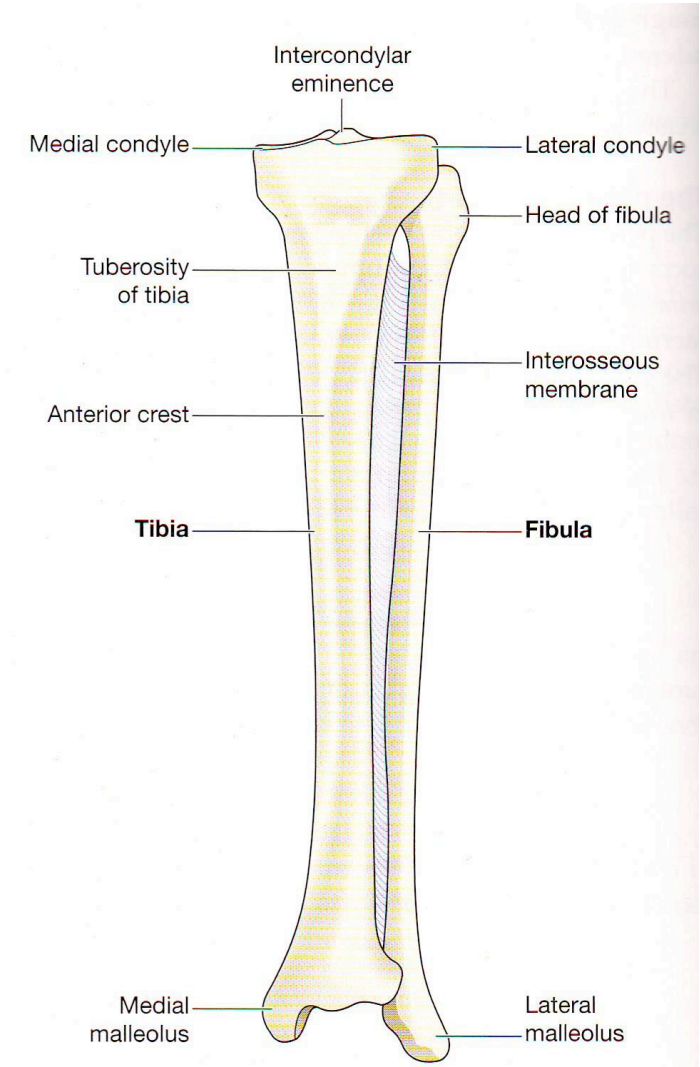
The two tibial diameters may be expressed as the Platyenemic Index:

transverse enemic diameter/sagittal enemic diameter x 100, with values as follows:

Platyenemic or very flat	x - 62%
Mesoenemic or moderately flat	63 - 69.9%
Euryenemic or broad	70 - x%

Measurement of the Fibula

1. Maximum length: this is measured from the styloid process to the bottom of the lateral malleolus. The styloid process is also referred to as the apex, which projects upward from the posterior part of the head.



The left tibia and fibula with the interosseous membrane. Anterior view.

Measurements of Teeth

There are many measurements taken on the individual teeth, thus there are many indices derived from these measurements.

Typically in anthropology measurements are done in millimeters, however, anthropometric work applied to teeth requires measurements of 1 /10 of a mm. Such detailed work requires special calipers as well as highly specialized training and thus is best left to the anthropologist.