MANI-002
PHYSICAL ANTHROPOLOGY

Indira Gandhi
National Open University
School of Social Sciences

Block

8

PRACTICAL IN PHYSICAL ANTHROPOLOGY

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BLOCK 8 PRACTICAL IN PHYSICAL ANTHROPOLOGY

Introduction

Physical Anthropology in current context is an exploration of adaptation that took place during the course of evolution. From morphological studies to genetic and to genetic-environment, physical anthropology has had a long journey which still continues all in endeavor to understand our past, present and future intrinsically. It is primarily a research-based discipline. Practical is an application of the theoretical knowledge. Practicals in physical anthropology has opened the doors for applied research in diverse fields committed to understand every aspect of man more minutely because of its strength to absorb new techniques in its framework. This is one of the reasons for the changing definition of physical anthropology over the years.

The block Practical in Physical Anthropology consists of four units. These units have been designed in such a manner that it also gives you a fair idea of the applications too. **Unit 1** based on Osteology and Instrument used has two components in it: Osteology and Instruments Used. The skeletal system of human and bones are discussed briefly in the osteology section whereas a brief description of the instruments used for taking measurements of bones and human being are dealt in Instrument Used. The measurements of human body is not only important in evolutionary perspective but it also holds immense significance in racial classification and designing purposes; **Unit 2** has sections on craniometry; measurement on cranium, mandibulometry: measurement on mandible or lower jaw, somatoscopy: visual observation of physical features of various parts of human body and somatometry: measurement on living human body. **Unit 3** has physiological variables i.e., measurement of blood pressure, heart rate and pulse rate and am sure you would enjoy taking them. Serology and dermatoglyphics are the genetic traits and brief description of the technique used to analyse the blood groups (serology) and palm and finger print (dermatoglyphics) is given in **Unit 4**. Each technique and its procedure is given very clearly in the block, hope you enjoy it.

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UNIT 1 OSTEOLOGY AND INSTRUMENTS USED

OSTEOLOGY

Practical forms an important component in understanding theory we learn. In this unit let us get familiar with important bones in our body including skull. Osteology is the scientific study of bones and understanding of human skeleton constituting an important part of Physical Anthropology.

Skeleton: The skeleton is a bony and cartilaginous framework of the body.The skeletal framework is found either internally or externally. In some vertebrate animals it is found both internally and externally.

Endoskeleton: The skeleton is located internally in the body.

Exoskeleton: The skeleton is located externally. In human beings the exoskeleton is rudimentary and is represented by nails and enamel of teeth.

Functions of Skeleton

1) It constitutes the framework of the body and gives form and shape to the body.
2) Forms the central axis of the body.
3) Supports and transmits the weight of the body.
4) Provides levers essential for locomotion.
5) Gives attachments to muscles and ligaments.
6) Provides protection to vital organs such as brain, heart and lungs.

The human skeleton consists of 206 bones, and is divided into two major portions- the axial skeleton and the appendicular skeleton (Fig 1.1).

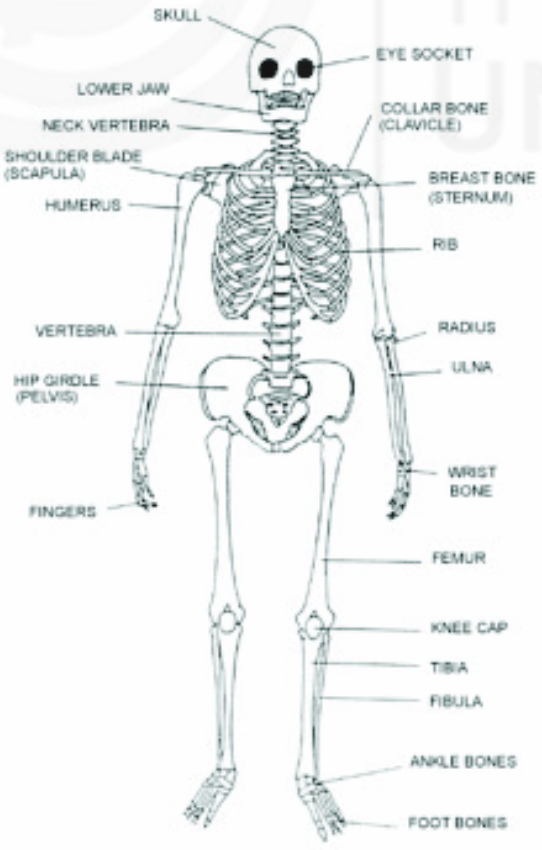


Fig.1.1: Human Skeleton (Anterior View)
Source: 365ayearofdailytasking

Axial skeleton: The axial skeleton consists of the bony and cartilaginous parts. It consists of the 80 bones and it is formed by the Vertebral column (26), the Rib cage (12 pairs of ribs and the sternum), and the Skull (22 bones and 7 associated bones).

Appendicular Skeleton: The appendicular skeleton consists of a total of 126 bones and is formed by the pectoral girdles (4), the upper limbs (60), the pelvic girdle (2), and the lower limbs (60).

The appendicular skeleton is divided into six major regions:

1) Pectoral Girdles (4 bones) – Left and right Clavicle (2) and Scapula (2).
2) Arm and Forearm (6 bones) – Left and right Humerus (2) (Arm), Ulna (2) and Radius (2) (Fore Arm).
3) Hands (58 bones) – Left and right Carpal (16) (wrist), Metacarpal (10), Proximal phalanges (10), Middle phalanges (8), distal phalanges (10), and sesamoid (4).
4) Pelvis (2 bones) – Left and right os coxae (2) (ilium).
5) Thigh and leg (8 bones) – Femur (2) (thigh), Tibia (2), Patella (2) (knee-cap), and Fibula (2) (leg).
6) Feet (56 bones) – Tarsals (14) (ankle), Metatarsals (10), Proximal phalanges (10), middle phalanges (8), distal phalanges (10), and sesamoid (4).

Classification of Bones: There are five types of bones in the body. They are long bones, short bones, flat bones, irregular bones and sesmoid bones.

1) **Long bones:** Each long bone has an elongated shaft or diaphysis and two expanded ends (epiphyses) which are smooth and articular. Examples of typical long bones are humerus, radius, ulna, femur, tibia and fibula, metacarpals, metatarsals and phalanges.

2) **Short bones:** Short bones are defined as being approximately as wide as they are long and have a primary function of providing support and stability with little movement. Examples: carpal and tarsal bones in the wrist and foot.

3) **Flat Bones:** These bones resemble shallow plates and form boundaries of certain body cavities. The example of a flat bone is the scapula, sternum, cranium, pelvis and ribs.

4) **Irregular bones:** The bones, which cannot be grouped under any of the above groups, are included in this category. Bones of the vertebral column, sacrum and mandible are the best examples.

5) **Sesamoid bones:** These are bony nodules found embedded in the tendons or joint capsules. The patella (knee cap) is a good example.

The following is the brief description of skull, pelvis, long bones (femur, radius, ulna, femur, tibia and fibula), clavicle, scapula and sternum.

Skull: Skull (Fig. 1.2) is the upper most part of the human skeleton consisting of head and face. The human skull usually consists of 22 bones. Except for the mandible (lower jaw), all of the bones of the skull are connected together by

sutures. The skeleton of a skull without mandible is called Cranium which is made up of with 8 bones and thirteen bones form the facial skeleton. The mandible is a movable bone held to the cranium by ligaments.

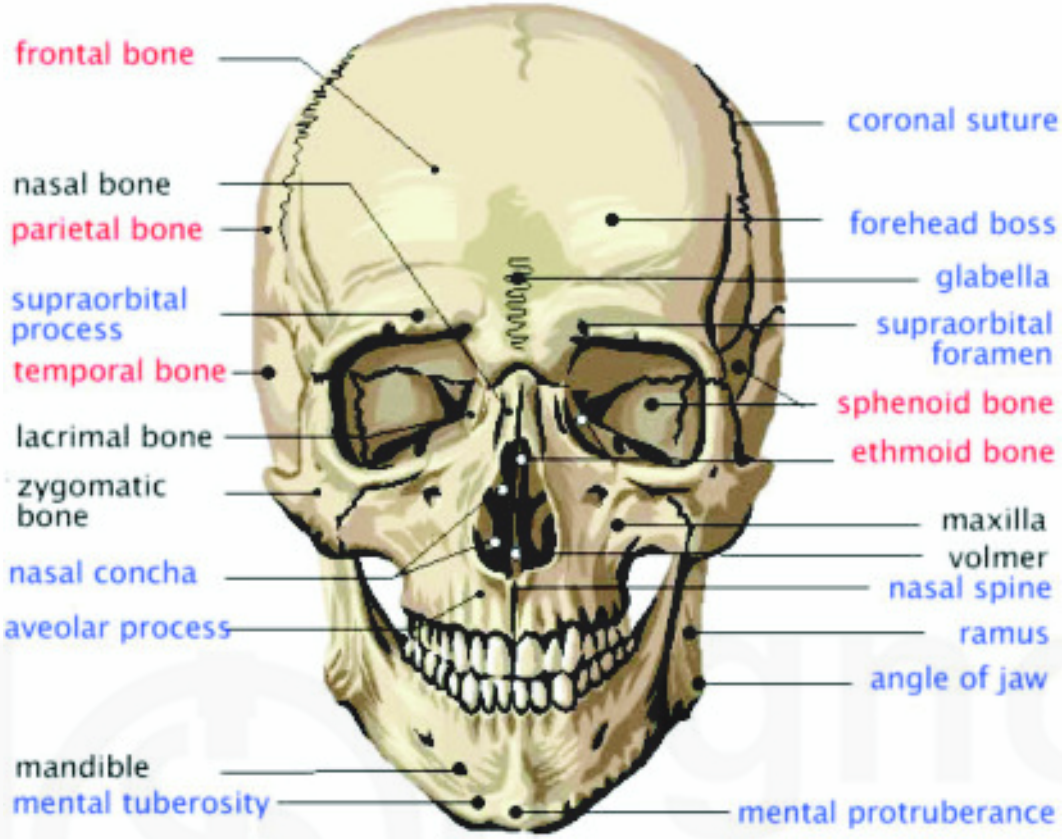


Fig.1.2: Skull (Anterior view)
Source: face-and-emotion.com

The cranial bones can be divided into two categories: the calvaria and the cranial base. The calvaria is the dome-shaped superior portion of the cranium. It is composed of the frontal, occipital, and parietal bones, and the flat portion of the temporal bones. The cranial base is composed of the two remaining cranial bones, the ethmoid and the sphenoid bone. Fourteen facial bones form the other components of the skull. The facial bones are composed of the inferior nasal conchae, lacrimal bones, mandible, maxillary bones, nasal bones, palatine bones, vomer and zygomatic bones.

Let us get familiar with the description of the bones of the Cranium and Facial skeleton.

Cranium

Eight bones constitute the cranium. The eight bones are, frontal (1), parietal (2), occipital (1), temporal (2), sphenoid (1) and ethmoid (1).

Frontal bone: The frontal bone forms the anterior part of the skull above the eyes. On the upper margin of each orbit, the frontal bone is marked by a supraorbital foramen and or supraorbital notch.

Parietal bones: The two parietal bones jointly constitute upper part of the lateral wall of the cranium. One parietal bone is located on each side of the skull, just behind the frontal bone. Both the parietal bones jointly form the bulging sides and roof of the cranium.

Occipital bone: This bone forms the back of the skull and the base of the cranium. The lambdoidal suture connects the occipital bone and the parietal bones. There is a large opening on its lower surface called the foramen magnum. Occipital condyles, which are rounded processes are located on each side of the foramen magnum, articulate with the atlas (first vertebra) of the vertebral column.

Temporal bone: On each side of the skull the temporal bone joins the parietal bone along a squamosal suture. Parts of the sides and the base of the cranium are formed by the temporal bones. The external auditary meatus, is an opening which is located near the inferior margin and leads to inward parts of the ear. We find there are two projections-a rounded mastoid process and a long, pointed styloid process under the external auditary meatus. A zygomatic process projects anteriorly from the temporal bone and joins the zygomatic bone.

Sphenoid bone: On the anterior portion of the cranium this sphenoid bone is wedged between numerous other bones. It consists of a central part and two greater and two lesser wings. The base of the cranium, sides of the skull and floors and sides of the orbits are formed by the sphenoid bone. A portion of the sphenoid bone rises up and forms a saddle shaped mass called the *sella turcica*.

Ethmoid bone: The ethmoid bone is cubical in shape and is very light. It is situated at the anterior part of the base of the cranium and contributes in forming the medial walls of the orbits, the septum of the nose, and roof and lateral walls of the nasal cavity.

Facial Skeleton

The facial skeleton consists of fourteen bones of which thirteen are immovable, the lower jaw being a movable bone. These bones include, Maxilla (2), Zygomatic (2), Lacrimal (2), Nasal (2), Inferior nasal conchae (2), Palatine (2), Vomer (1) and Mandible (1).

Maxillary bones: The upper jaw is formed by the maxillary bones. The inferior border of each maxillary bone projects downward forming an alveolar process. These processes together form a horseshoe-shaped alveolar arch. The anterior roof of the mouth, floor of the orbits, and sides and floor of the nasal cavity comprise the portions of maxillary bones. These bones also contain the sockets of the upper teeth. Lateral to the nasal cavity, inside the maxillae are maxillary sinuses, which are the largest of the sinuses. In course of development to form the anterior section of the hard palate, portions of the maxillae (palatine processes), grow together and fuse along the midline. The alveolar process is formed by the inferior border of each maxillary bone which is projecting downwards. Together these processes forms a horseshoe shaped alveolar arch.

Zygomatic bones: The prominences of the cheeks below and to the sides of the eyes are formed by these zygomatic bones. In the formation the lateral walls and floors of the orbits the zygomatic bones helps a lot. Each of these zygomatic bones has a temporal process, which extend posteriorly to unite the zygomatic process of a temporal bone. Jointly these two processes (temporal process, zygomatic process) form a zygomatic arch.

Lacrimal bones: The lacrimal bone is situated in the medial wall of each orbit between the ethmoid bone and maxilla.

Nasal bones: These nasal bones lie side by side and are fused at the midline and form the bridge of the nose. The nasal bones are long, thin and almost rectangular.

Inferior nasal conchae: These bones are scroll-shaped, delicate and attached to the lateral walls of the nasal cavity. The inferior conchae, provide support for mucous membranes within the nasal cavity like that of the superior and middle conchae.

Palatine bones: Each bone is more or less L-shaped. These palatine bones are situated at the back the maxillae. The horizontal portions serve as both the posterior section of the hard palate and the floor of the nasal cavity. The lateral walls of the nasal cavity are formed by the perpendicular portions of the palatine bones.

Vomer: Vomer is located in the midsagittal line. This bone articulates with the sphenoid and the ethmoid bones and the left and right palatine bones. It also articulates with the left and right maxillary bones.

Mandible: The mandible is a movable bone held to the cranium by ligaments and consists of a horizontal, horseshoe-shaped body with a flat portion projecting upward at each end.

These two processes called an anterior coronoid process and the other is a posterior mandibular condyle. The coronoid processes serve as attachments for muscles used in chewing where as the mandibular condyles articulate with the mandibular fossae of the temporal bones. The other large chewing muscles are inserted on the lateral surface of the mandible. The alveolar arch that contain the hollow sockets bear the lower teeth.

Morphologically, the human skull can be studied in five different views

Norma verticalis - Superior view

Norma basalis - Inferior view

Norma frontalis - Anterior view

Norma Occipitalis - Posterior view

Norma Lateralis - Lateral view

Norma Verticalis (Fig 1.3 and 1.4): The general contour of the cranium, the nature and the eminences as well as the nature of the sutures can be better understood by studying cranium in this view. In this view some skulls are oval while some appear circular in shape. In this view portions of frontal, two parietal and occipital bones, and also three sutures namely the coronal sutures, the sagittal suture and lambdoid sutures are seen. The point of junction of the sagittal suture with the coronal sutures is termed the bregma and that of the sagittal and lambdoid sutures is termed the lambda. The landmarks like coronale, bregma, euryon, and opisthocranion are seen in this view.

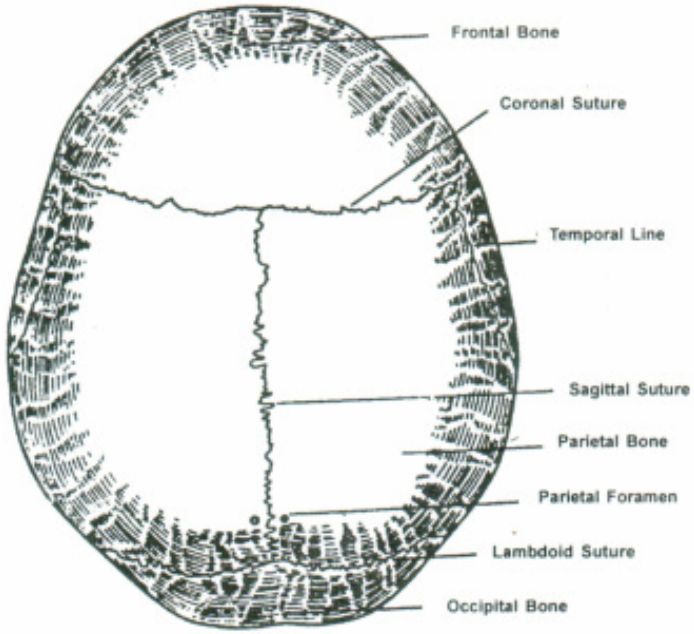


Fig.1.3: Norma Verticalis

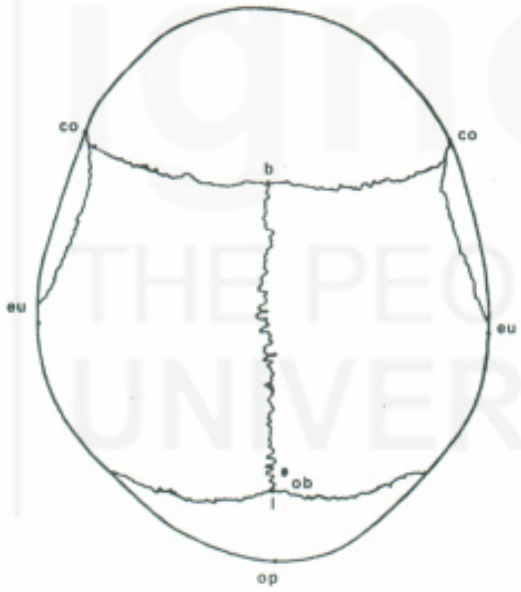


Fig.1.4: Norma Verticalis with landmarks

Norma Frontalis (Fig. 1.5 and 1.6): In this view, the skull exhibits somewhat oval outline, wider above than below and limited above by the frontal bone, zygomatic bone and the mandibular rami on the lateral side and mandible on the lower side. The skull in this view is divided into two major parts, the upper and lower. The upper part is mostly formed by the frontal bone, and the lower part which is made up of the bones of the face is irregular with two orbits and the anterior bony aperture of the nose. The lateral margins and the lower border of the facial part are formed by the Mandible.

The following is the brief account on the upper and lower parts.

Upper part: The curved elevations of the frontal bone known as supraorbital ridges, just above the orbits joined to one another in the middle by the glabella. The nasal bones meet the frontal bone in the fronto-nasal suture, which is below the glabells and the mid point of is termed as nasion. The two rounded eminences

above the supraorbital ridges one on either side are known as frontal eminences. Parts of parietal, temporal and sphenoid wings are seen in this upper part.

Lower Part: When we observe the skull from the lower part, the orbits are quadrangular in shape. The upper margins of orbits are entirely formed by the frontal bone, and the lateral margins are formed by the zygomatic process of the frontal bone above, and by the frontal process of the zygomatic bone, below. The infraorbital margins are formed medially by the maxillae and laterally by the zygomatic bone. Between the maxillæ and below the nasal bones is seen the pyriform aperture. This pyriform aperture is surrounded by pointed margins and to this the lateral and alar cartilages of the nose are attached. Viewing of the skull in norma frontalis, the mandible exhibits mainly the alveolar margin, chin region and the mental foramina. The gonion is the lateral most and inferior point on angle of the jaw.

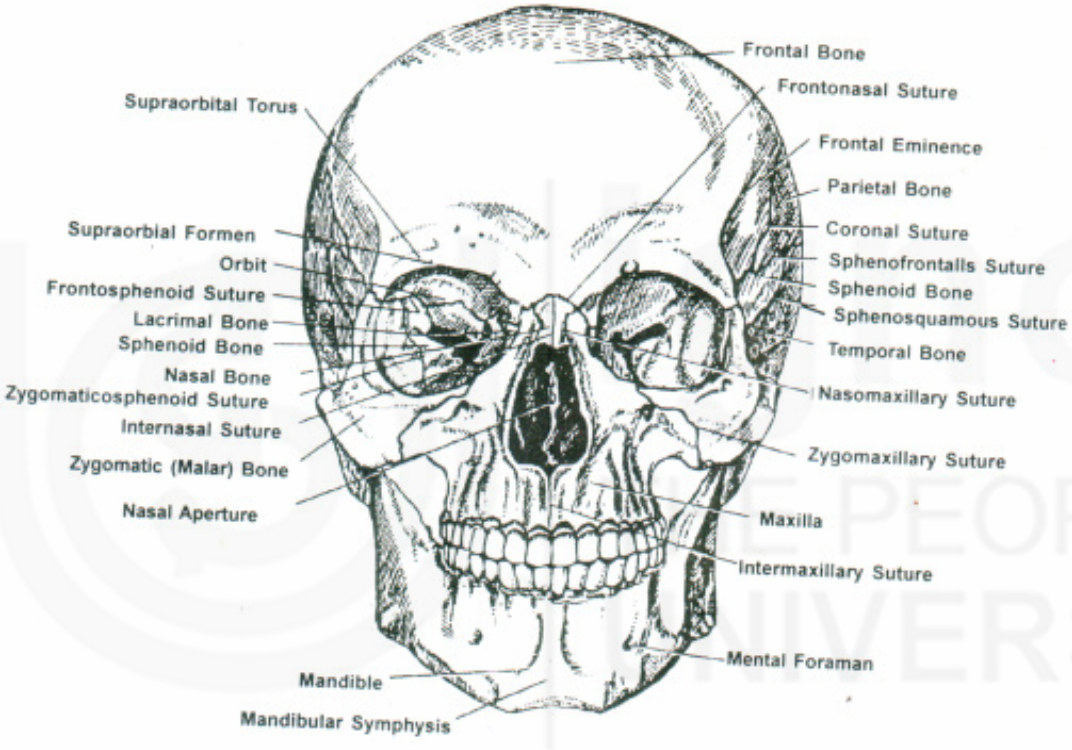


Fig.1.5: Norma Frontalis

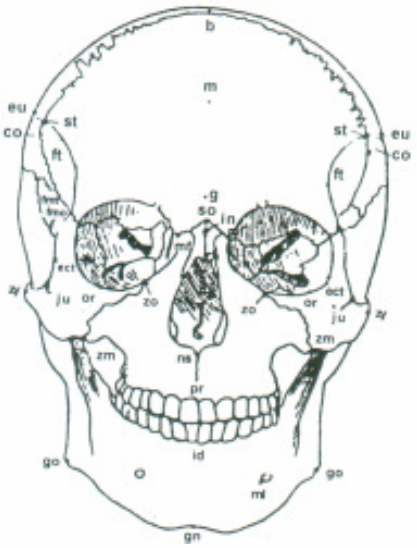


Fig.1.6: Norma frontalis with land marks

Norma Basalis (Fig. 1.7 and 1.8): When we view the skull in this position from the external surface, (excluding the mandible) it is surrounded by the incisor teeth in front; by the superior nuchal lines of the occipital behind; and by the alveolar arch laterally. In this position palatine processes of the maxillæ and palatine bones, the pterygoid processes, the vomer, spinous processes, and parts of sphenoid, the surfaces of the squamæ and mastoid and petrous portions of the temporals, and the surface of the occipital bone, are found. The hard palate forms the *anterior* part where as the *middle* and *posterior* parts are formed by a transverse line drawn through the anterior margin of the foramen magnum. The surface of the skull in this norma is very irregular and is separated into anterior, middle and posterior portions.

On the anterior part of norma basalis, both antero-posteriorly and transversely, the palate is arched. The palatine vault is greatest in the region of the molar teeth with respect to the depth and breadth. The maxillae and the horizontal plates of the palatine bones form the bony plate of the palatine process. These are divided from one another by a cruciform suture, made up the intermaxillary, interpalatine and palatomaxillary sutures. On the middle part of this norma, the pterygoid process of the sphenoid bone descends behind the third molar from the junction of its greater wing and the body. The medial pterygoid plate is narrower of the two and projects directly backwards. The posterior border of the vomer separates the two posterior nasal apertures in the medial plane anteriorly. The tympanic piece of the temporal bone separates the articular fossa from the external auditory meatus. On the posterior part of the norma basalis, the foramen magnum of the occipital bone occupies the anterior part. The antero-posterior distance is greater than the transverse and it is in oval shape. On each side by the occipital condyles, the margin of the foramen is slightly interrupted on anterior side and it projects downwards to articulate with the atlas. There lies a jugular foramen between the occipital bone and the jugular fossa. The external occipital crest is seen on the squamous part of the occipital bone on the median plane behind the foramen magnum.

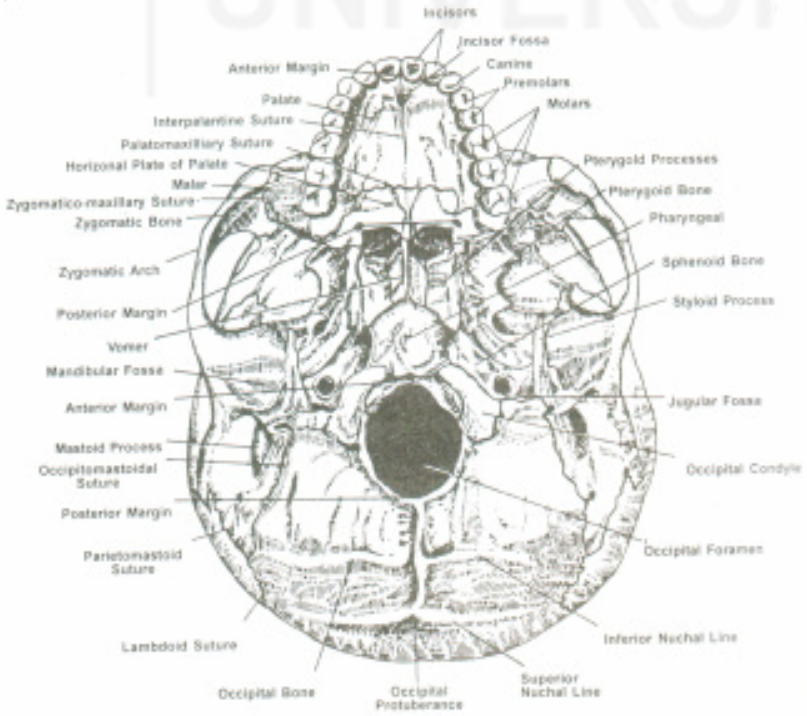


Fig.1.7: Norma Basialis

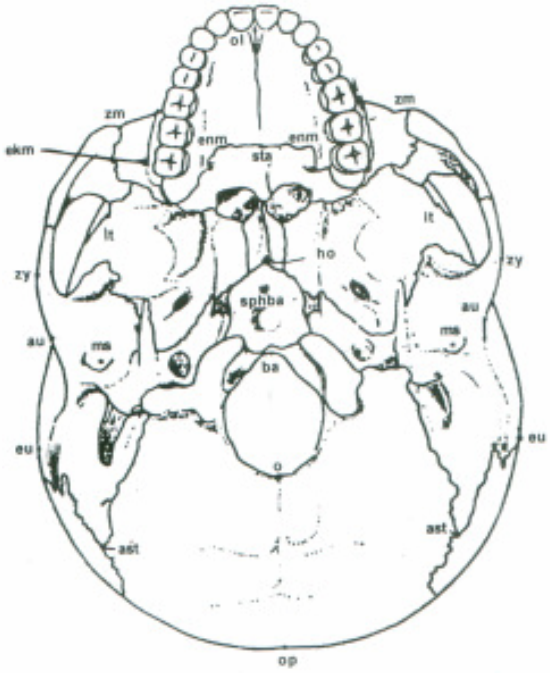


Fig.1.8: Norma Basialis with Land marks

Norma Lateralis (Fig. 1.9 and 1.10) : In this view the skull consists of the cranium above and behind, and of the face below and in front. The cranium is rather ovoid in shape. The contour varies from cases and depends largely on the length and height of the skull. In this view seen are the frontal, the parietal, the occipital, the temporal, and the greater wing of the sphenoid bone.

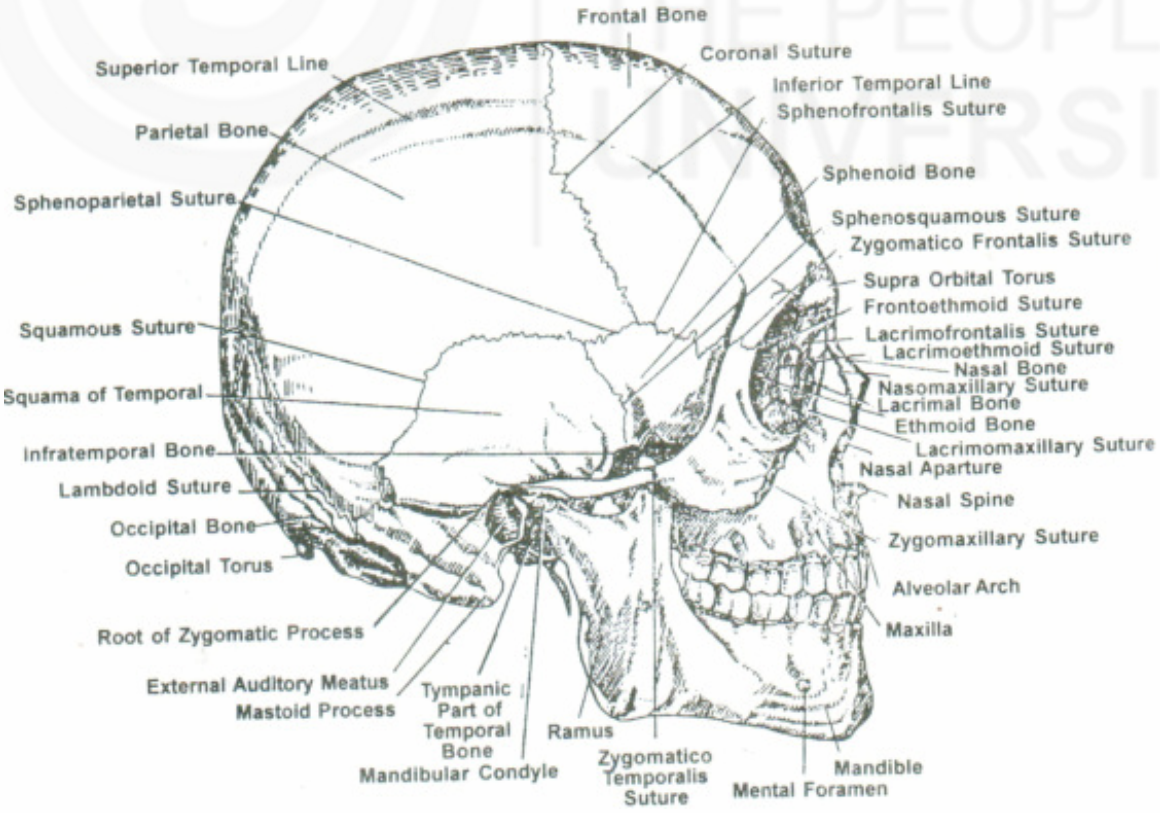


Fig.1.9: Norma Lateralis

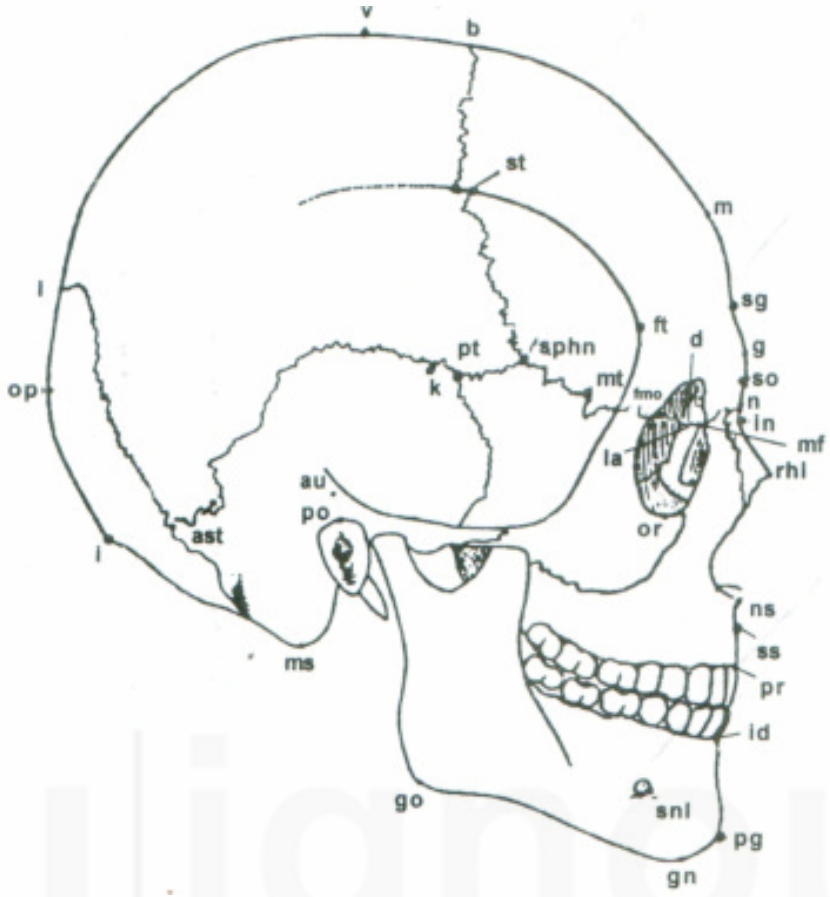


Fig.1.10: Norma Lateralis with Land marks

The frontal process of the zygomatic bone and the temporal line is called the temporal fossa. The bottom of the temporal fossa gives origin to the temporalis muscle and it in turn controls the movements of the mandible. The temporal process of the zygomatic bone and the zygomatic process of the temporal bone forms the zygomatic arch. The glenoid fossa is formed by the zygomatic process of the temporal bone (the zygoma), which widens posteriorly as it approaches the squamous part which is divided into an anterior and posterior root which form the respective borders of the articular fossa. The posterior part of the posterior root of the zygoma open by the external auditory meatus. The external meatus is formed by the tympanic plate of the temporal bone from the anterior, inferior and the lower part of the posterior margin. The mastoid process articulates with the parietal bone in parietomastoid suture and it articulates posteriorly with the occipital bone in occipitomastoid suture. In this view of the cranium the parts like, the alveolar margin, the mental protuberance, the condyloid process, part of the coronoid process, the sigmoid notch, the body of the mandible are seen.

Norma Occipitalis (Fig. 1.11 and 1.12) In this position the cranium is more or less circular outline. The two mastoid processes forms the base of the arch. External occipital protuberance is seen in this norma and this is situated on the lower part of the field in the median plane with the ridges leading out from it. Passing laterally from the protuberance, the superior nuchal lines are the distinct ridges which form the boundary lines between the scalp and the back of neck. The land mark 'inion' is observed prominently on the external occipital protuberance.

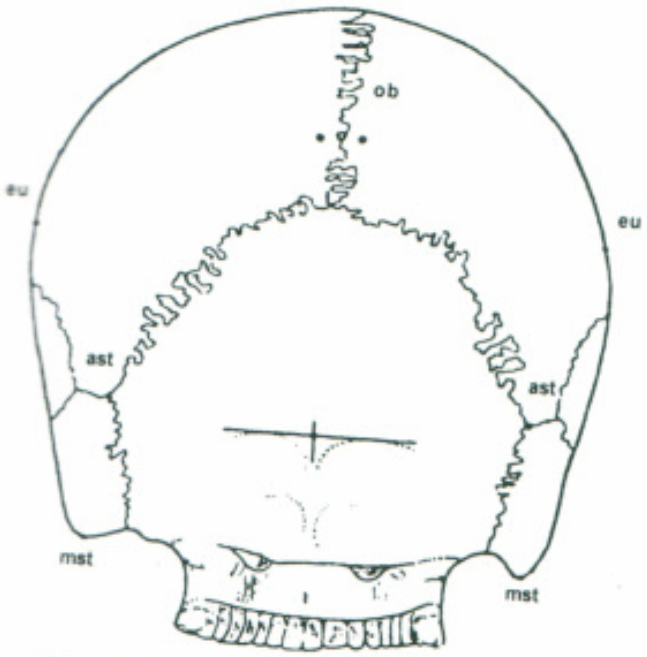


Fig. 1.11: Norma Occipitalis with Land marks

Pelvis

The pelvis (Fig. 1.12), lies between the segments of the vertebral column and the lower limbs and looks like a basin. Pelvis consists of four bones: the two hip bones laterally and in front and the sacrum and coccyx behind. The pelvis is divided into a greater (false) pelvis and lesser (true) pelvis. The expanded portion of the cavity above the pelvic inlet which is bound on each side by the ilium and behind by the base of the sacrum is the greater pelvis. The pelvic cavity which is located below and behind the pelvic brim forms the true pelvis. The true pelvis possesses an inlet, outlet, and a cavity.

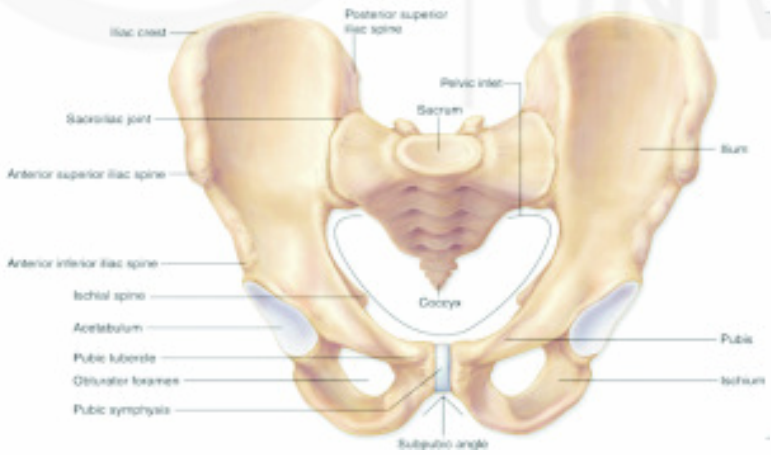


Fig.1.12: Pelvis
Source: graphicshunt.com

The boundaries of the inlet constitute brim of the pelvis and it is heart shaped. It consists of three main diameters: antero-posterior which is extending from the lumbosacral angle to the symphysis pubis; transverse and which is extending from the iliopubic eminence to the opposite sacroiliac joint. The outlet is bound behind by the apex of the coccyx and laterally by the ischial tuberosities and it is

irregular in shape. The antero-posterior diameter of the outlet is extended from the apex of the coccyx to the lower part of the symphysis pubis. The transverse diameter of the outlet is extended between the broadest parts of the lateral walls. The cavity is a short and curved canal considerably deeper behind than in front.

Hip bone: This is the large bone of the pelvis and is irregular in shape. Each hip bone develops from three parts, an ilium, an ischium, and a pubis. These three parts fuse in the walls of the acetabulum. This depression is on the lateral surface of the hipbone, and it receives the rounded head of the femur. The ilium includes the upper part of the acetabulum and the ischium includes the lower part of the acetabulum. The two partner hip bones articulate anteriorly at the symphysis pubis. A portion of each pubis passes posteriorly and downward to join ischium. On either side of these bones and between the bodies we find a large opening. This is called the obturator foramen. The obturator foramen is the largest foramen in the skeleton.

Pectoral Girdle

The pectoral girdle, also call it as shoulder girdle consists of the clavicle and scapula in humans. We find on the dorsal (posterior) part two scapula and on the anterior (ventral) part two clavicles.

Scapula: Scapula is a flat, triangular bone, with two surfaces (dorsal and costal), three borders (superior, lateral and medial) and three angles (inferior, superior and lateral). We find scapula on the posterior part of the pectoral girdle. The dorsal surface of each scapula is divided into unequal portions by a spine. This spine leads to two processes, an acromion process, which forms the tip of the shoulder, and a coracoid process, which curves forward and downward below the clavicle. The acromion process articulates with the clavicle. The acromian and the coracoid process also provides attachments for arm and chest muscles. Between the acromion and coracoid processes there is a depression called the glenoid cavity. This cavity articulates with the head of the humerus.

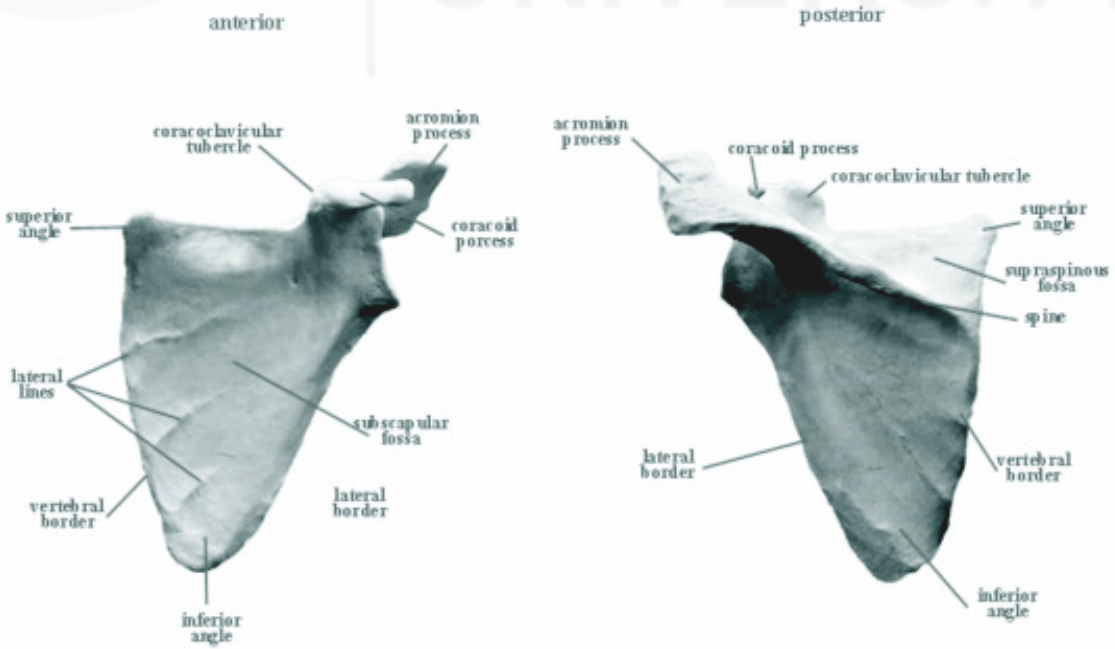


Fig. 1.13: Scapula
Source: reel.utsc.utoronto.ca

Clavicle: It is a long, curved bone which forms the anterior part of the pectoral girdle. It is a slender, rodlike bone with elongated S-shape. It is located at the base of the neck and run horizontally between the manubrium and scapula. The clavicle has two ends (sternal and acromial), two borders (anterior and posterior), and four surfaces (anterior, posterior, upper and inferior). The lateral, or acromial end is flattened and articulates with the acromion of the scapula.

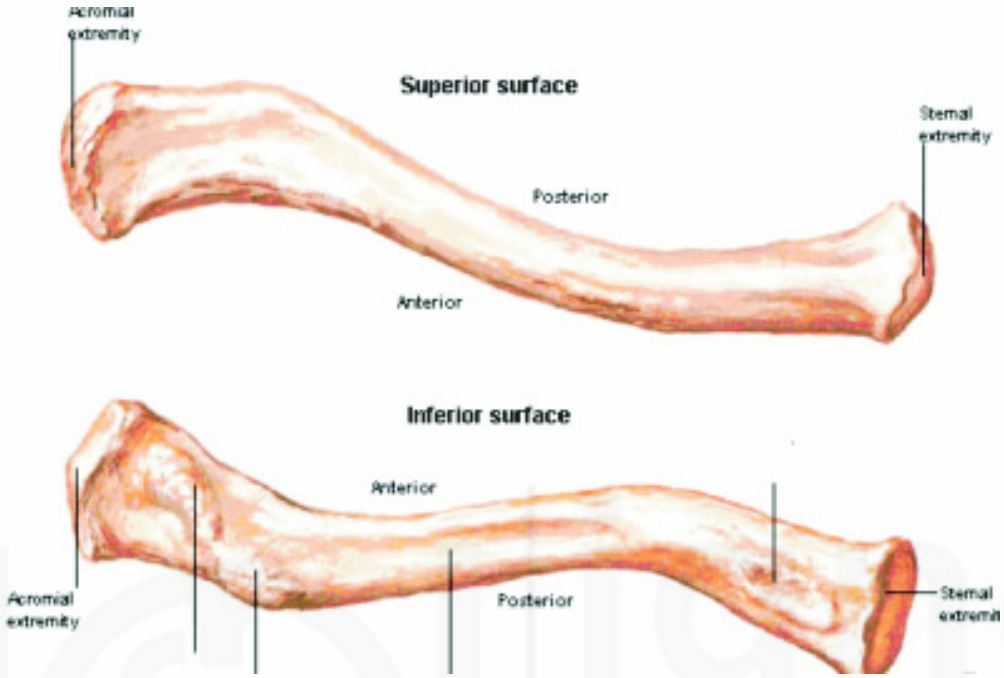


Fig.1.14: Clavicle

Source: blissfullyaesthetic.bl...

Sternum: The sternum or breastbone is located along the midline in the anterior portion of the thoracic cage. The sternum from the upper end supports the clavicle, and its margins articulate with the cartilage of the first seven pairs of ribs. Sternum is a flat, elongated bone that consists of three parts, an upper manubrium, a middle body and a lower xiphoid process, which projects downwards. The manubrium articulates with the clavicles by facets on its superior borders.

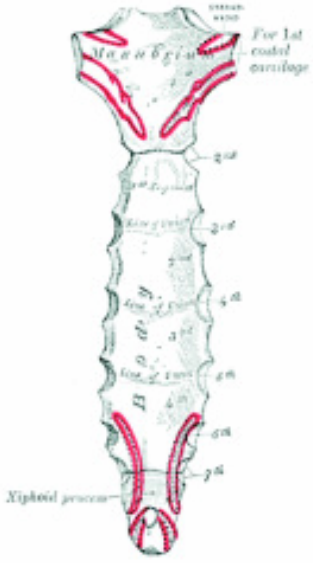


Fig.1.15: Sternum

Source: learnbones.com

Limbs: Human skeleton consists of upper limbs and lower limbs. The arm, wrist, palm and fingers form the upper limbs. The arm is divided into upper arm and forearm. The upper arm contains a single bone the humerus, the forearm with two bones, radius and ulna and the wrist, palm and fingers contain carpals, metacarpals and phalanges. The bones of the lower limb form the framework of the leg, ankle, foot and toes. The bones of the lower limb include femur, tibia, fibula, tarsals, metatarsals and phalanges.

Humerus: The humerus is a heavy and longest bone that extends from the scapula to the elbow. It has a cylindrical shaft and two (upper and lower) extremities. The upper extremity has a smooth rounded head that fits into the glenoid cavity of the scapula. Just below the head, there are two processes- a greater tubercle on the lateral side and a lesser tubercle on the anterior side. The lower extremity consists, anteriorly the two smooth condyles (a lateral capitulum and a medial trochlea), and two fossae- lateral (radial) and medial (coronoid); and posteriorly, the olecranon fossa which lodges the olecranon process of ulna. The capitulum articulates with the head of the radius.

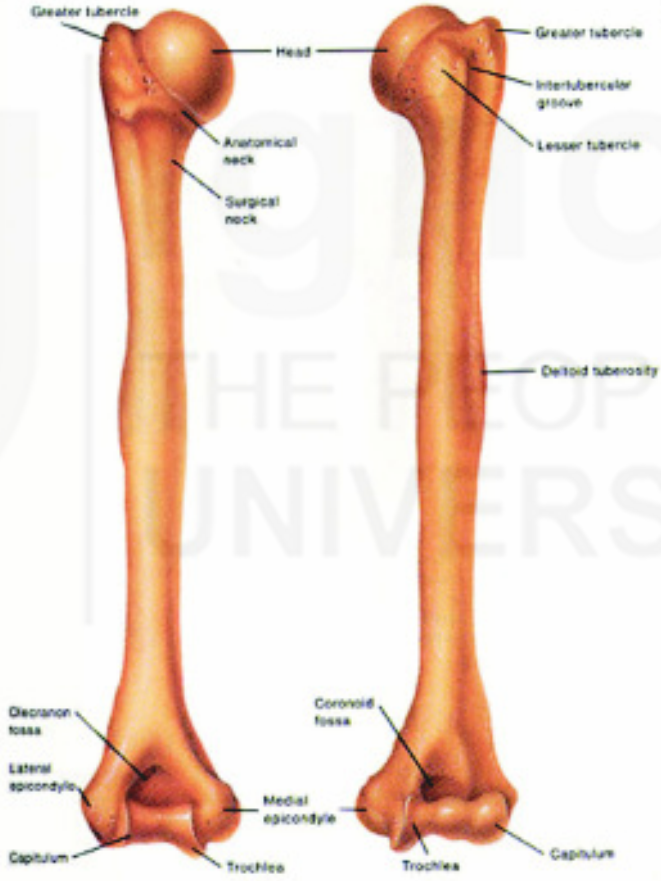


Fig.1.16: Humerus

Source: edoctoronline.com

Radius: Radius is the lateral bone of the forearm. It has two extended ends-the head and the lower end, and a shaft. The head at the upper end of the radius articulates laterally with the humerus and a notch of the ulna. On the shaft, just below the head is a process called the radial tuberosity. The lower end of the radius contains styloid process which is projected downwards from the lateral surface.

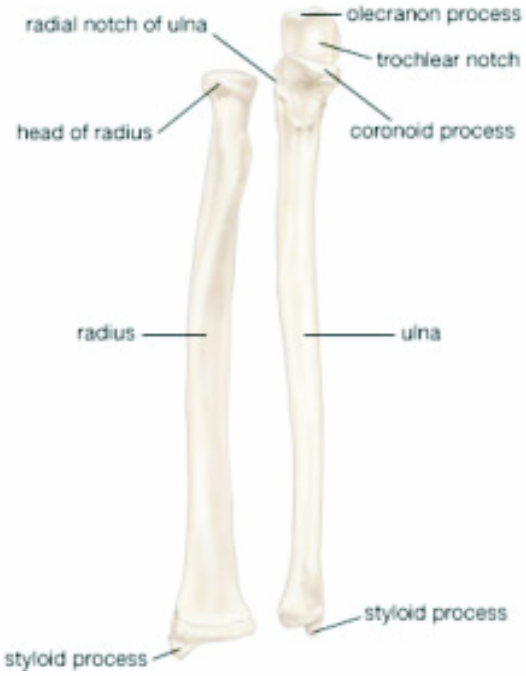


Fig. 1.17: Radius and Ulna
Source: britannica.com

Ulna: It is a thick, strong and its upper end looks like a hook. The Ulna bone faces anteriorly and is the medial bone of the forearm. The upper end has two processes the olecranon and the coronoid process. The lower end has the knoblike head of the ulna, articulates with a notch of the radius laterally and with a disk of fibrocartilage inferiorly. In cross-section the shaft of the ulna is triangular and becomes gradually narrow from the upper to the lower end.

Femur: The femur is the longest bone in the human body. The femur extends from the hip joint to the knee joint. It consists of upper and lower ends and a shaft. The upper end has a large rounded head, a neck and a greater and a lesser trochanter. The head of the femur projects medially into the acetabulum of the hip bone. The lower end of the femur consists of the two condyles – the lateral and medial condyles, which articulate with the head of the tibia (of the lower leg) and then patella (knee-cap).

The shaft of the femur at the anterior side is nearly cylindrical and convex while it is thinnest at the middle and widens more near the lower end when compared to above.

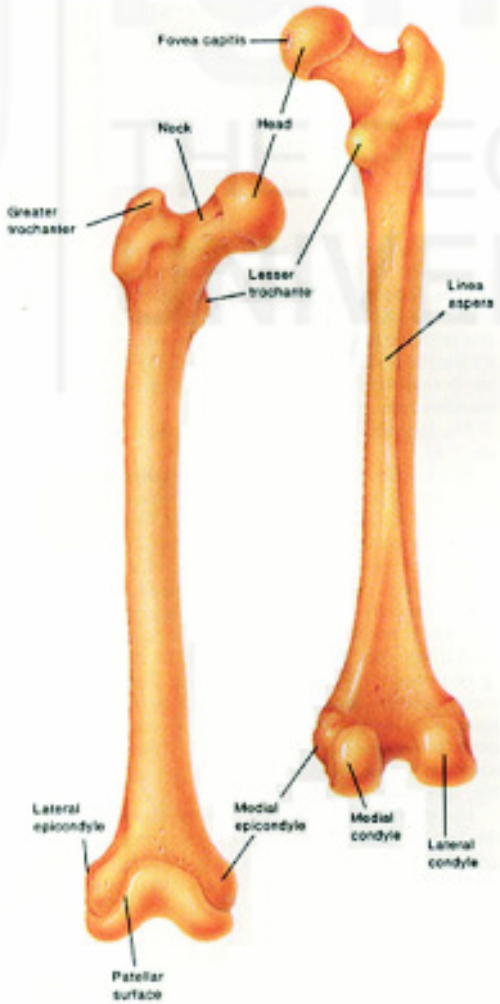


Fig.1.18: Femur
Source: edoctoronline.com

Tibia: The tibia is located on the medial side and the larger of the two lower leg bones. It consists of an upper end, lower end and a shaft. The upper end is expanded into two condyles, the medial and lateral condyles. These two have concave surfaces and articulate with the condyles of the femur. The lower end of tibia expands to form a prominence on the inner ankle called the medial malleolus. The lower end articulates with the trochlear surface of the talus at the ankle joint. The shaft of the tibia is triangular in cross-section and has three surfaces – medial, lateral and posterior, and three borders-anterior, interosseous and medial.

Fibula: The fibula is located on the lateral side of the tibia and is a long and slender one. It consists of a shaft, an upper end (head) and a lower end (the lateral malleolus). The head of the fibula articulates with the tibia just below the lateral condyle. The lateral malleolus articulates with the ankle and forms a eminence on the lateral side. The shaft of the fibula has three borders anterior, posterior and interosseous.

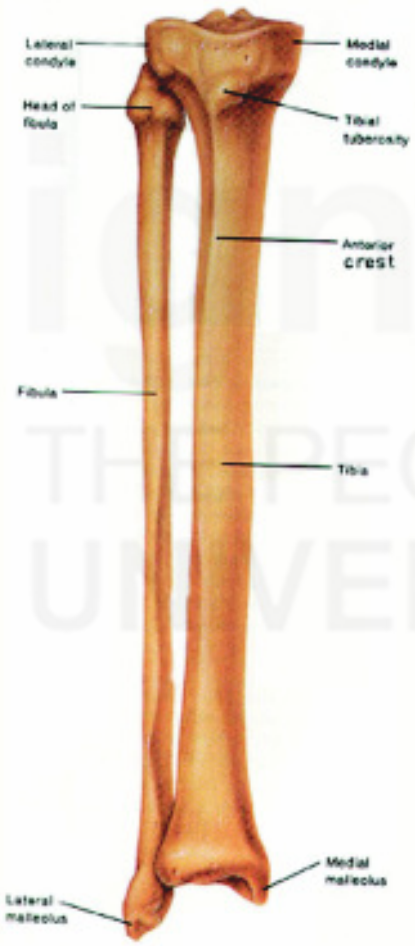


Fig. 1.19: Tibia and Fibula
Source: physioweb.org

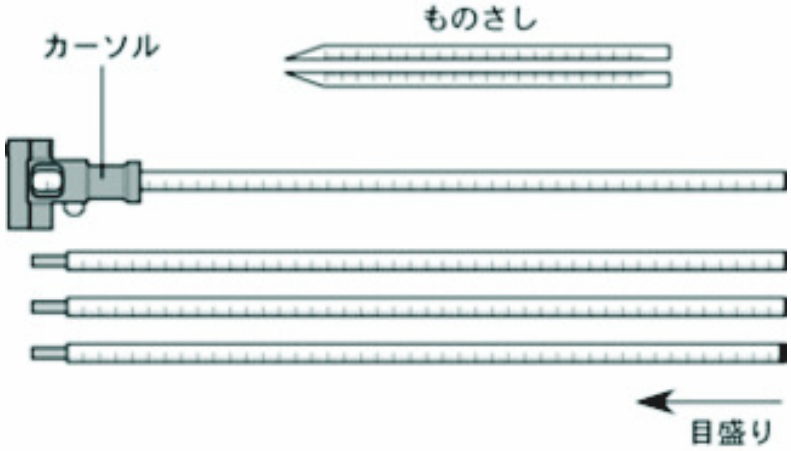
INSTRUMENTS USED

Craniometry (measurement of cranium), Mandibulometry (measurement of mandible) and Somatometry (measurement of the dimensions of body) involve different types of instruments for taking measurements depending upon its nature. Here we will mention briefly about the instruments to be used in our list of measurements.

Weighing machine: Standard weighing machine with a graduation of 500 grams, portable for field purpose and stationary weighing machines are used. The zero error should be adjusted with the knob provided. Weight of the subject with minimum clothing is preferred and adjustment for the clothes should be made.

Source:k3505907 www.fotosearch.com

Martin's Anthropometer: It is the most often used instrument in somatometry used for taking linear measurements. The anthropometer consists of four equal graduated segments which when joined tightly measures 200 cms. The graduation begins at the base of the lowest segment on one side and from uppermost segment on the other side on opposite side. The uppermost segment bears at its upper end fixed casket, while there is another casket which can move up and down along the oriented rod. The casket holds the cross bars which are also graduated. The movable casket provides an elongated window on its body, through which the graduations can be seen and upper border of this opening gives a particular measure.



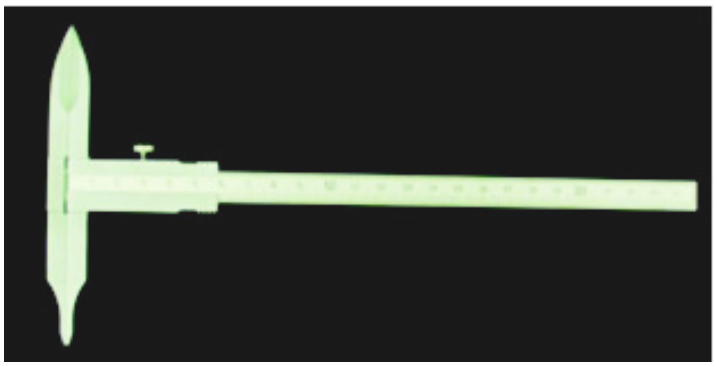
Source:www.riodb.ibase.aist.go.

Rod compass: The first segment of the anthropometer used as a large sliding caliper by adjusting the crossbar is called rod compass. It is graduated in descending order starting from the top fitted with fixed socket. It is used to measure breadths or diameters.

Martin's Spreading caliper: It is mainly used for taking head and face measurements where curved areas are involved. It consists of two long arms which are curved outwards and straight on the other end which is screwed together so that arms can move freely. A meter scale (35cm) is fixed to one of the arms and passes though the socket of the second arm. The screw at the back socket provides to and fro movement to the scale. The free ends of the long arms are provided either with blunt (used in living beings) or pointed end (used in skeletons). Another large variety of spreading caliper having a scale of 60cm, used for measuring pelvis is called pelvimeter.

Source: www.theapricity.com

Martin's Sliding caliper: It consist of long straight scale graduated on both sides and two cross bars one fixed on one end of the scale and other one parallel to the fixed one which can slide over the scale with the help of socket provided with a screw to be used to fix the socket at any place. Both the arms are projected to an equal distance on both sides of the scale. The scale is graduated starting from fixed end up to 250mm. Again from the free end it is graduated up to 50mm- this is used for measuring depths when the movable socket is fitted on the scale in reverse order. Sliding caliper is used to measure shorter breadths. The blunt ends are used to measure on body (living beings) while the sharp end on bones.



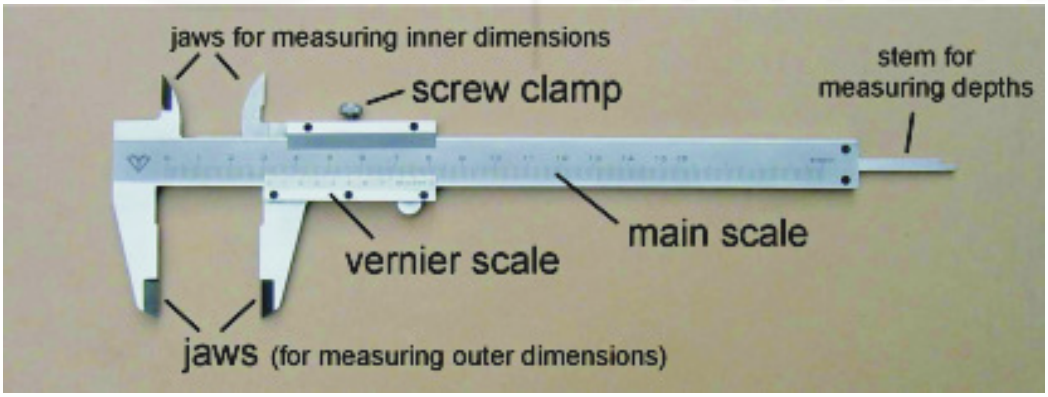
Source: www.riodb.ibase.aist.go

Skinfold caliper: The purpose of the skinfold caliper is to measure the thickness of the skinfold for assessment of subcutaneous fat at different sites of the body. Harpenden and Lange's skinfold calipers are mostly used for the purpose. The caliper consists of round clock like dial fitted with sturdy grip above which is an elongated lever. The caliper at the contact surface of the arms should be kept at a pressure of 10 gm/mm^2.

Harpenden's skinfold caliper

Source: www.physicalcompany.co.uk

Vernier caliper: Vernier calipers give readings of high accuracy. This caliper possesses a calibrated scale with fixed jaw and another one with a pointer that slides along the scale. The distance between the two jaws gives the reading depending upon its usage. Vernier calipers are used to measure internal dimensions, external diameters and depth.

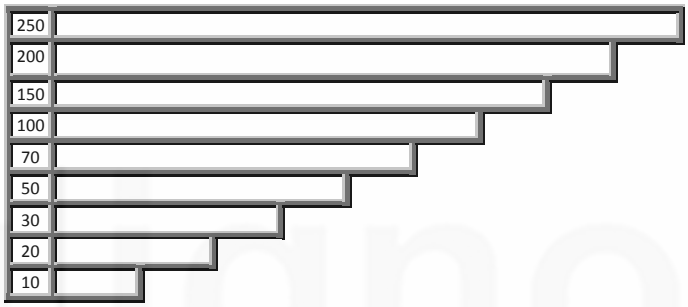


Source: www.phy.uct.ac.za

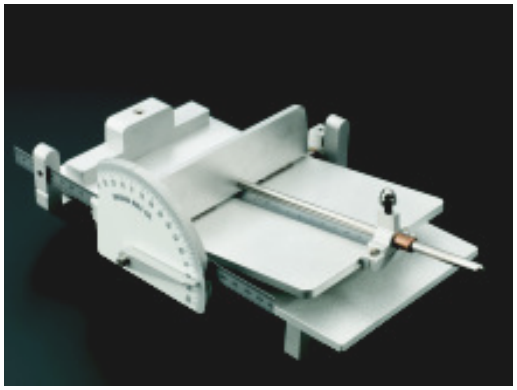
Steel tape: It is made of flexible steel graduated on both the sides wound in a metal case from which it can be pulled out and can rewind after use. It is used for measuring girths of different parts of body and skeleton which involves curvature.

Source: www.oneinhundred.com

Verificator: It is also called Gauge and is used to verify the accuracy of the calipers. There are nine brass rods with different lengths varying from 10 to 250 mm.



Mandibulometer: A mandibulometer is a precision bone measuring (osteometric) instrument. An anthropologist or skeletal biologist uses it to measure the human lower jawbone. Professionals working in forensic science also use it. It consists of one horizontal plate, one vertical plate and a protractor. The horizontal plate serves as a base and graduated scale is there on both the sides. Near the rear end of the base is a vertical plate which is also provided with scales. This vertical plate is fixed with screws and it can be raised so as to suit the angle of mandible. This angle can be measured with protractor which is fixed at the intersection of the plates. Front side of the basal plate has a thick vertical piece, which can slide over the surface, and used to fix mandible on the front side.



Source: www.sciencemuseum.org.uk

Suggested Reading

The list is given at the end of unit 4.

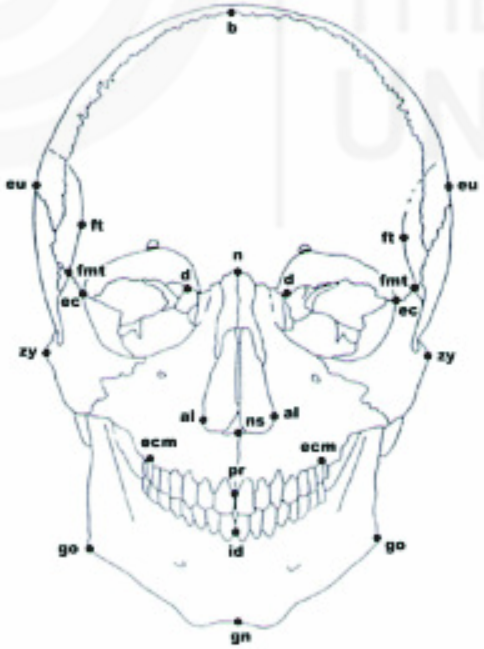
UNIT 2 CRANIOMETRY, MANDIBULOMETRY, SOMATOSCOPY AND SOMATOMETRY

CRANIOMETRY AND MANDIBULOMETRY

Measurements on Cranium and Mandible

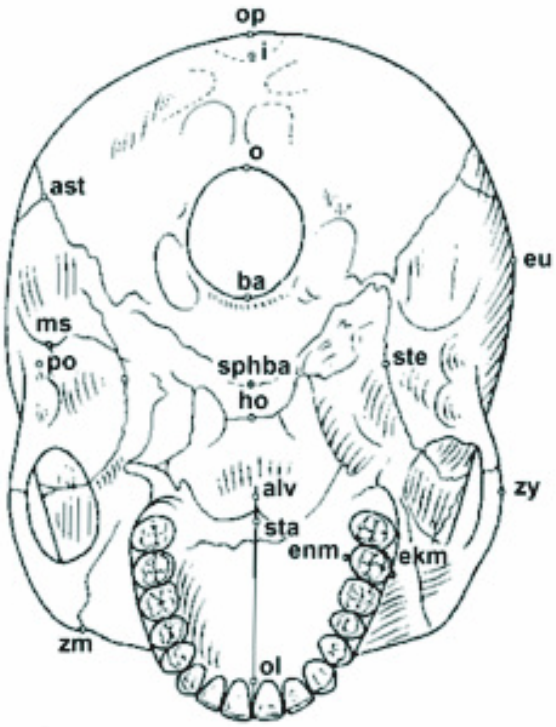
Introduction

Earlier in the unit we got familiar with the different bones of our body including the cranium and the mandible. Craniometry deals with the scientific measurements on human cranium. The objective behind Craniometry and Mandibulometry is to study the form and shape of human (or Primate) cranium and mandible, respectively. Its contribution towards identifying the age and sex of a cranium is it's another crucial usage. The development of various parts of human skull is dependent on genetic, morphological and functional factors. Cranium consists of two clear parts, brain cavity and the facial region. Craniometry includes both these regions. The measurements can be linear, transverse, angular, arc, depth, etc., and thus the instruments to be used should be specific depending upon the measurement. There are measurements that are taken directly on the skull, at the same time some are taken on the tracings of the skull. In case of direct measurement the cranium is placed on the cushion or on the pad or mounted on the craniophore. While taking the measurements one wonders the logic behind them. What, where and how to measure strikes one's mind. Every measurement that we take has a specified landmark as well as standard technique to follow. The landmarks are more easily located on the cranium as compared to those on the living (somatometry). Identifying the correct landmarks and following the standard techniques are the contributing factors which would yield best and precise results. To identify the landmarks on skull refer to the following figures



b, Bregma – co, Coronale – d, Dakyon – ek, Ektokonchion – eu, Eurion – fmo, Frontomalare orbitate- fmt, Frontomolare temporale – ft, Frontotemporale – gn, Gnathion – go, Gonion – id, Infradentale – idd, Infradentale dentale – ju, Jugale – la,Lacrimale – mf, Maxillofrontale – ml, Mentale – n, Nasion – ns, Nasospinale – or, Orbitale – prl, Prominentia laterale – pr, Prosthion – prd, Prosthion dentale – rhi, Rhionion – st, Stephanion – zy, Zygion – zm, Zygomaxillare

Source: www.cleber.com. br BIDEGAIN,Cléber; CARVALHO, Marília. Manual para estudos craniométricos e cranioscópicos.pp:13, Fig. II,6



alv, Alveolon - ast, Asterion - ba, Basion - ekm, Ektomalare - enm, Endonmlare - eu, Eurion - ho, Hormion - i, Inion - ms, Mastoideale - o, Opisthion - op, Opisthokranion - ol, Orale - po, Porion - sphba, Sphenobasion - sta, Staphylion - ste, Stenion - zy, Zygion - zm, Zygomaxillare.

Source: www.cleber.com.br BIDEGAIN,Cléber; CARVALHO, Marília. Manual para estudos craniométricos e cranioscópicos.pp: 9 Fig. II,1

PRACTICE 1

To take the following measurements on the three crania provided.

Maximum Cranial Length

Maximum Cranial Breadth

Least Frontal Breadth

Length of the Foramen Magnum

Maximum Cranial Length (g-op): It measures the straight distance between landmarks glabella (g) and opisthocranion (op).

Glabella **(g):** It is the point on the protuberance of the lower forehead above nasal root and between the eyebrow ridges intersected by mid-sagittal plane, i.e., it is the most anterior point in the median plane between the brow ridges.

Opisthocranion **(op):** It is the most posterior point on the posterior protuberance of the occipital bone of the head in the mid-sagittal plane, i.e., it is the point on the back of the head, farthest away from the glabella in the median plane. It is not an anatomically fixed point.

Instrument: Spreading caliper, skin marking pencil.

Method: Place the skull on the cushion with norma lateralis (preferably left side) upwards. Keep the tip of the left arm of the spreading caliper on glabella and move the tip of right arm of the caliper on the occipital bone in mid-sagittal plane, and record the maximum reading.

Precautions: Take care that the tip of right arm of the caliper is in the mid- sagittal plane.

While taking the measurement, the cranium should be in norma lateralis position.

Opisthocranion is the farthest point on the occipital bone in mid-sagittal plane, located by measuring the Maximum Cranial Length itself.

Maximum Cranial Breadth (eu-eu): It measures the maximum breadth taken at right angles to the mid-sagittal plane between the two euryon landmarks.

Euryon **(eu):** It is the lateral most point on the lateral wall of the skull on the parietals, i.e., sides of the head. Again, it not an anatomically fixed point.

Instrument: Spreading caliper, skin marking pencil, spirit, cotton.

Method: Place the cranium on a cushion with norma verticalis facing upwards. Now, hold the instrument in such a manner that the line joining its two tips is at right angle to the mid sagittal plane. How will you hold the instrument? Hold the arms of the caliper horizontally on the parietal bones while standing behind the skull. With the instrument in that position the maximum breadth is obtained by moving the two arms in different directions- forwards, backwards, upwards and downwards and maximum reading is recorded.

Precautions: The maximum measurement should be taken wherever found as euryon is not anatomically fixed point.

Inferior temporal point should be avoided.

Note that the two ends of caliper lie in a horizontal plane at right angles to mid-sagittal plane.

Least Frontal Breadth (ft-ft): It measures the straight distance between two fronto temporale (ft) landmarks.

***Fronto temporal* (ft)**: It is the most projecting and inward point of the superior temporal line i.e., the most median point on the incurve of the superior temporal line.

Instrument: Sliding caliper, skin marking pencil.

Method: Place the cranium on the cushion with norma frontalis facing you. Move the two ends of the caliper on the temporal crests of the two sides of skull to locate the frontotemporale points to record the minimum breadth.

Precautions: Take care that the linear distance between the two temporal lines on the forehead is measured.

The two fronto temporale landmarks should be symmetrically placed with reference to the median line.

Length of the Foramen Magnum (ba-o): It measures the straight distance between basion (ba) and opisthion (o).

***Basion* (ba):** It is the point where the anterior margin of the foramen magnum is cut by the mid-sagittal plane. This point lies exactly opposite to the opisthion. For height measurements, basion is defined as the lowest point on the anterior margin of foramen magnum in the mid-sagittal plane.

***Opisthion* (o):** It is the point where the posterior margin of the foramen magnum cuts the mid sagittal plane. This point lies exactly opposite to the basion.

Instrument: Sliding caliper, skin marking pencil.

Method: Place the skull in such a way that its Norma basalis is facing upwards, you will realise that skull is actually upside down. The end of the fixed crossbar is placed against basion and then the movable crossbar is slided over to touch the opisthion point.

Precautions: Note that the ends of the instrument must rest on the margins of foramen magnum.

Practice 1

Measurement (landmarks) (Units)	Cranium 1	Cranium 2	Cranium 3
Maximum Cranial Length (g-op) (cms)			
Maximum Cranial Breadth (eu-eu) (cms)			
Least Frontal Breadth (ft-ft) (cms)			
Length of the Foramen Magnum (ba-o) (cms)			

PRACTICE 2

To take the following measurements on the three crania provided

Nasal Height

Nasal Breadth

Length of the Nasal Bone

Nasal Height (n-ns): It measures the straight distance between the nasion (n) and nasospinale (ns).

Nasion **(n):** It is the point on the nasal root intersected by mid-sagittal plane or the meeting point of the fronto-nasal and inter-nasal suture. Nasal root is not the depression of the nose but at the nasao-frontal suture which can be felt by slightly probing the root of the nose. i.e., just apply a moderate pressure below your glabella and you will notice a sharp kink. Note that nasion usually lies in the level of the medial end of the eye-brows ridges mostly on the lower margins and not at the height of the eye-brows ridges.

Nasospinale **(ns):** It is the deepest point on the lower margin of the pyriform aperture projected in the mid-sagittal plane i.e., the point where a line touching the lower margin of the nasal aperture crosses the mid-sagittal plane. When the nasal spine is not too strongly developed, this landmark may be determined by drawing a straight line touching the lowest points of the margins of right and left pyriform apertures. Nasospinale lies at the point where this line is cut by mid-sagittal plane. When the spine is strongly developed, the point tends to lie on the spine itself. In that case the point is marked on the lateral side of the spine. It is recommended that reading should be taken on both the sides and that a mention of same be made.

Instrument: Sliding caliper, skin marking pencil, spirit, cotton.

Method: Place the sharp ends of the cross bar on the nasion and then slide the movable crossbar so that it touches nasospinale.

Precautions: The landmark nasion should be in mid sagittal plane.

Nasal Breadth: It measures the maximum breadth between the lateral margins of the pyriform aperture.

Instrument: Sliding caliper, skin marking pencil.

Method: Place the cranium on the cushion with norma frontalis facing upwards. Also note that the measurement is taken from above. The fixed crossbar is held tangent to the left border of nasal aperture, taking care that it is parallel to the median line. The movable casket is moved tangent to the other border. Hold the two points of the caliper on the sharp lateral margins of the aperture when they are most laterally arched and record the measurement.

Precautions: This measurement must be taken horizontally i.e., at right angles to mid-sagittal plane.

Length of the Nasal Bone (n-rhi): It measures the straight distance between nasion (n) and rhinion (rhi).

Nasion **(n):** It is the point on the nasal root intersected by mid-sagittal plane or the meeting point of the fronto-nasal and inter-nasal suture. Nasal root is not the

depression of the nose but at the nasao-frontal suture which can be felt by slightly probing the root of the nose. i.e., just apply a moderate pressure below your glabella and you will notice a sharp kink. Note that nasion usually lies in the level of the medial end of the eye-brows ridges mostly on the lower margins and not at the height of the eye-brows ridges.

***Rhinion* (rhi):** It is the lowest point on the internasal suture in the mid-sagittal plane.

Instrument: Sliding caliper, skin marking pencil.

Method: Place the sharp end of the fixed crossbar on the nasion and then slide the movable crossbar to the rhinion. Record the reading on the scale.

Precautions: Note that the landmark rhinion is in mid sagittal plane.

If the nasal bones are broken or otherwise defective, then this measurement should not be taken.

Practice 2

Measurement (Landmarks) (Units)	Cranium1	Cranium 2	Cranium 3
Nasal height (n-ns) (cms)			
Nasal breadth (cms)			
Length of the nasal bone (n-rhi) (cms)			

PRACTICE 3

To take the following measurements on the three crania provided

Facial length or Facial depth

Upper Facial Height

Morphological Facial Height

Horizontal Circumference of Cranium

Bizygomatic Breadth

Facial length or Facial depth (ba-pr): It measures straight distance between the basion (ba) and prosthion (pr).

Basion (ba): It is the point where the anterior margin of the foramen magnum is cut by the mid-sagittal plane. This point lies exactly opposite the opisthion. For height measurements, basion is defined as the lowest point on the anterior margin of foramen magnum in mid-sagittal plane.

Prosthion (pr): It is the point which lies on the alveolar margin of the upper jaw in the mid-sagittal plane, projecting most anteriorly between the two central incisors. This point lies on the most anterior side. Actually you can also locate it as the lowest point of the intermaxillary suture on alveolar border between the two middle incisors. In case of defective alveolar margin, this measurement should not be taken.

Instrument: Sliding caliper, skin marking pencil.

Method: Place the cranium on cushion with norma basalis facing upwards. Then the fixed end of the caliper is placed on prosthion while the movable crossbar is drawn to the level of basion and record the reading.

Precautions: Locate prosthion carefully as the point lies on the most anterior side.

Upper Facial Height (n-pr): It measures straight distance between nasion (n) and prosthion (pr).

***Nasion* (n):** It is the point on the nasal root intersected by mid-sagittal plane or the meeting point of the fronto-nasal and inter-nasal suture. Nasal root is not the depression of the nose but at the nasao-frontal suture which can be felt by slightly probing the root of the nose. i.e., just apply a moderate pressure below your glabella and you will notice a sharp kink. Note that nasion usually lies in the level of the medial end of the eye-brows mostly on the lower margins and not at the height of the eye-brow ridges.

***Prosthion* (pr):** It is the point which lies on the alveolar margin of the upper jaw in the mid-sagittal plane, projecting most anteriorly between the two central incisors. This point lies on the most anterior side. Actually you can also locate it as the lowest point of the intermaxillary suture on alveolar border between the two middle incisors. Incase of defective alveolar margin, this measurement should not be taken.

Instrument: Sliding caliper, skin marking pencil.

Method: Rest the cranium on its occipital region with the norma frontalis facing upwards. The sharp end of the fixed crossbar of the instrument is placed on the nasion and then the movable crossbar is slided to touch the prosthion point with its sharp end.

Precautions: Locate prosthion carefully as the point lies on the most anterior side.

Horizontal Circumference of Cranium (g-op-g): It measures the horizontal circumference of the cranium from glabella to glabella through opisthocranion.

***Glabella* (g):** It is the point on the protuberance of the lower forehead above nasal root and between the eyebrow ridges intersected by mid-sagittal plane i.e., it is the most anterior point in the median plane between the brow ridges.

***Opisthocranion* (op)**: It is the most posterior point on the posterior protuberance of the occipital bone of the head in the mid-sagittal plane i.e., it is the point on the back of the head, farthest away from the glabella in the median plane. It is not an anatomically fixed point.

Instrument: Flexible Steel Tape, Spreading Caliper, skin marking pencil.

Method: In order to take this measurement first we need to determine opisthocranion landmark. This we shall do with use of spreading caliper as we did earlier while measuring maximum cranial length (Practice 1). After we have determined and marked opisthocranion, place the skull on the cushion with norma verticalis facing upwards. Now place the free end of tape over glabella and pass the tape over the superciliary ridges in front and opisthocranion behind and back to glabella, and maximum reading is recorded.

Precaution: The tape should pass over opisthocranion.

Morphological Facial Height (n-gn): It measures the straight distance between the nasion (n) and gnathion (gn).

***Nasion* (n):** It is the point on the nasal root intersected by mid-sagittal plane or the meeting point of the fronto-nasal and inter-nasal suture. Nasal root is not the depression of the nose but at the nasao-frontal suture which can be felt by slightly probing the root of the nose. i.e., just apply a moderate pressure below your glabella and you will notice a sharp kink. Note that nasion usually lies in the level of the medial end of the eye-brows mostly on the lower margins and not at the height of the eye-brows.

***Gnathion* (gn):** It is the lowest point on the lower margin of the mandible in the mid-sagittal plane.

Instrument: Sliding caliper.

Method: Keep the skull on the cushion. Place the tip of sliding caliper at the gnathion, and then slowly slide the moveable end superiorly until it contacts nasion. Record the distance.

Precautions: Care should be taken to identify nasion correctly and not as depression on the nose.

Bizygomatic Breadth (zy-zy) : It measures the straight distance between the two zygion (zy) landmarks i.e., the most laterally placed point on the zygomatic bone.

Zygion **(zy)**: It is the lateral most point on the zygomatic arch, one on each side. Anatomically it is not fixed point.

Instrument: Sliding or Spreading caliper, skin marking pencil.

Method: Rest the cranium on its base facing you. Move the two ends of the caliper forwards and backwards on the two zygomatic arches to obtain the maximum value.

Precautions: The two ends of the caliper should be in one horizontal plane and it's joint in the mid-sagittal plane.

Practice 3

Measurement (Landmarks) (Units)	Cranium1	Cranium 2	Cranium 3
Facial length/facial depth (ba-pr) (cms)			
Upper facial height (n-r) (cms)			
Horizontal Circumference of Cranium (g-op-g) (cms)			
Morphological facial height (n-gn) (cms)			
Bizygomatic breadth (zy-zy) (cms)			

PRACTICE 4

To take the following measurements on the three crania provided

Bimaxillary Breadth or Breadth of the Upper Jaw

Bi-Auricular Breadth

Palatal Length

Palatal Breadth

Bimaxillary Breadth or Breadth of the Upper Jaw (zm-zm): It measures the straight distance between the two zygomaxillare (zm).

***Zygomaxillare* (zm):** It is the deepest external and lowermost point on the zygomaxillary suture.

Instrument: Siding caliper, skin marking pencil.

Method: Place one pointed end of fixed crossbar of caliper on one zygomaxillare and then slide the other end touching the other zygomaxillare and record the reading.

Precautions: The landmark should be identified correctly.

Bi-Auricular Breadth (au-au): It measures the straight distance between the two auriculare landmarks (au).

***Auriculare* (au)**: It is the point where the perpendicular on the ear opening (external auditory meatus) crosses the root of the zygomatic arc. It lies a few mm. above porion landmark.

Instrument: Sliding or Spreading caliper, skin marking pencil, spirit, cotton.

Method: This reading can be taken more conveniently with spreading caliper by placing the cranium in norma verticalis or norma basalis. Place the end of left arm of the caliper on one auriculare and guard it with your thumb and forefinger of left arm, and then place the end of right arm of caliper on other auriculare.

Precautions: The reading should be taken from the front side of the skull.

Palatal Length (ol-sta): It measures the straight distance between orale (ol) and staphylion (sta).

***Orale* (ol):** It is the midpoint which lies on the anterior margin of the palate. To determine this point draw a tangent joining the two posterior margins of the middle incisors. Orale lies where this line cuts the mid-sagittal plane.

***Staphylion* (sta)**: It is the point where a straight line joining the deepest notches or curves of the posterior margins of the palate cut the mid-sagittal plane.

Instrument: Vernier or Sliding caliper, skin marking pencil.

Method: Place the cranium on the cushion upside down, in such a way that norma basalis is upwards. Locate the two anatomical points, then place the fixed end of the crossbar on one landmark and slide the movable crossbar to the other point and take the reading.

Precautions: Take care that the skull is placed on the cushion upside down, in such a way that norma basalis is upwards.

Palatal Breadth (enm-enm): It measures the straight distance between the middle of the inner margin of the alveolar on the second molar i.e., endomolare (enm) to endomolare (enm)

Endomolare **(enm):** It is the point located in the middle of the inner margin of the alveolar process opposite to the second upper molar in man.

Instrument: Sliding caliper, skin marking pencil.

Method: Place the cranium on the cushion upside down, with norma basalis upwards. Place the end of fixed crossbar against one endomolare, then slide the movable crossbar to touch other endomolare to take the reading. It is difficult to take this measurement on skull without teeth, absence of which changes the shape of alveolar margin.

Precautions: Locate the points carefully in the absence of teeth.

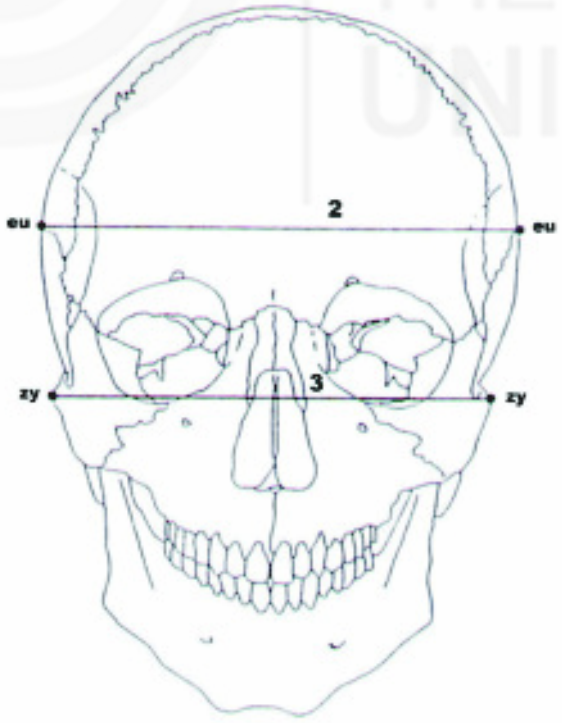
Practice 4

Measurement (Landmarks) (Units)	Cranium1	Cranium 2	Cranium 3
Bimaxillary breadth (zm-zm) (cms)			
Bi-auricular breadth (au-au) (cms)			
Palatal length (ol-sta) (cms)			
Palatal breadth (enm-enm) (cms)			

You can refer to these figures while taking the following measurements:

Maximum Cranial Breadth

Bizygomatic breadth



Source: www.redwoods.edu

Mandibulometry

Measurements taken on mandible are called Mandibulometry.

PRACTICE 5

To take the following measurements on the mandible provided

Bicondylar Breadth

Bigonial Breadth

Height of Ramus or Condylar Height

Mandibular length or Length of the Lower Jaw:

Bicondylar Breadth (cdl-cdl): It measures the straight distance between two condylion laterale (cdl).

Condylion laterale **(cdl**): It is the most lateral point of the condyle of the mandible.

Instrument: Sliding caliper, skin marking pencil.

Method: Hold the mandible in your left hand and adjust the inner border of the crossbar on the lateral ends of condyles. Place the end of the fixed crossbar against the most laterally placed point of one of the condyles of the mandible. Slide the movable crossbar to the other condyle to take the measurement.

Precautions: Only the most lateral points on the condyles should be used for the measurements.

Bigonial Breadth (go-go): It measures the straight distance between the two gonia (go).

Gonion **(go):** It is the most posterior, inferior and lateral point of the angle of the lower jaw or mandible made by the basal margin of the body and posterior margin of the ramus.

Instrument: Sliding caliper, skin marking pencil.

Method: Place the mandible inverted on the cushion and adjust the inner borders of the crossbar of the caliper on the lateral surface of the caliper. Place the end of the fixed crossbar against the most laterally placed point of one of the gonion. Slide the movable crossbar to the other gonion to take the measurement.

Precautions: The measurement should be taken vertically after marking the gonions correctly.

Height of Ramus or Codylar Height: It measures the straight distance between gonion (go) and highest point on the mandibular capitulum.

Gonion **(go):** It is the most posterior, inferior and lateral point of the angle of the lower jaw or mandible made by the basal margin of the body and posterior margin of the ramus.

Instrument: Sliding caliper or Mandibulometer, skin marking pencil.

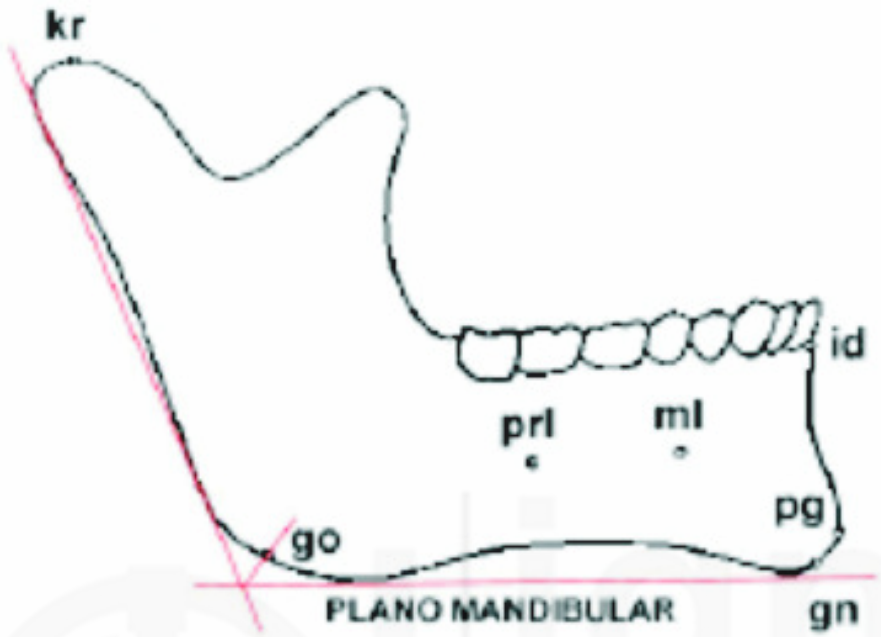
Method: Place the fixed end of the crossbar on the on top of the condyle. Now adjust the movable crossbar on the gonion and note the reading.

Mandibular length or Length of the Lower Jaw: It measures the straight distance from the most anterior point of mental eminence (in mid-sagittal plane) to a tangent drawn to the two gonion (go).

Instrument: Sliding caliper or Mandibulometer, skin marking pencil.

Method: Put a thin needle in a straight line crossing the two gonion points. Take the measurement in mid-sagittal plane from posterior margin of the chin to the needle to measure mandibular length.

Precautions: The needle should be kept horizontally straight and the measurement should be taken at the right angle to the needle.



gn, Gnathion – go, Gonion – id, Infradentale – kr, Koronion – ml, Mentale – pg, Pogonion – prl, Prominentia laterale

Source: www.cleber.com.br BIDEGAIN,Cléber; CARVALHO, Marília. Manual para estudos craniométricos e cranioscópicos.pp:17, Fig. II,10

Measuring Height of Ramus and Mandibular Length using Mandibulometer:

Method: Place the mandible on the horizontal movable plate of mandibulometer.

Adjust the vertical movable plate in such a manner that it forms a tangent to the posterior margins of the two ramus.

Slide the horizontal plate so that the fixed vertical plate in front touches the most anterior point of mental eminence.

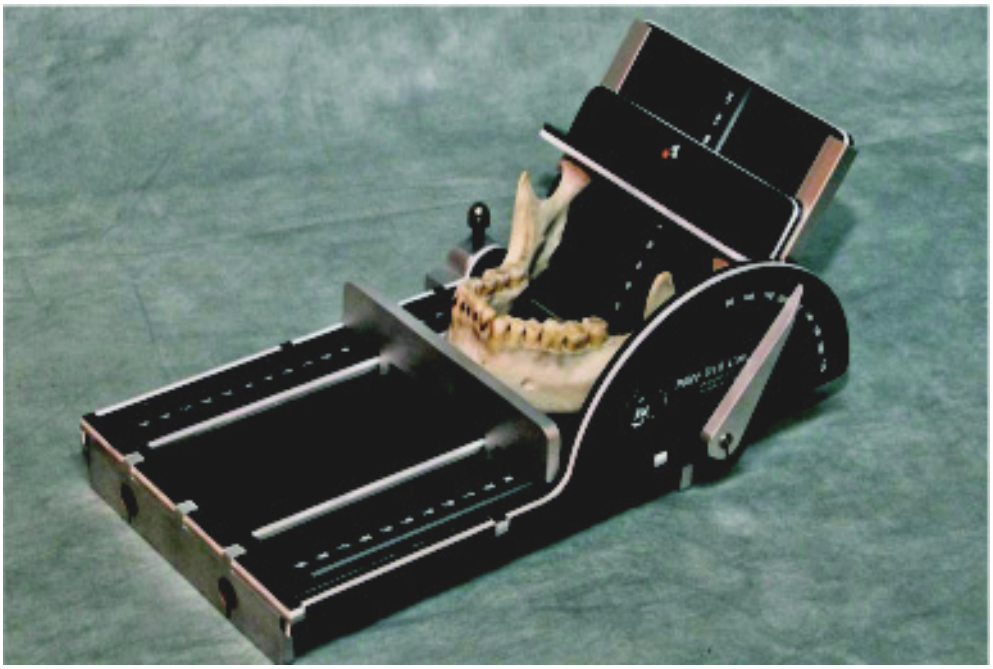
Now slide the small horizontal plate (adjusted in the movable vertical plate) so that it touches the highest point on the condyles.

Precaution: Height of ramus is taken from the scale given on vertical movable plate. and

Mandibular length is taken from the scale given on the horizontal movable plate.

Look at the figure below, this is how you should keep the mandible while taking measurements.

Measurement on Mandible



Source: www.pales-tech.com

Practice 5

Measurement (Landmarks) (Units)	Mandible 1	Mandible 2	Mandible 3
Bicondylar breadth (cdl-cdl) (cms)			
Bigonial breadth (go-go) (cms)			
Height of the ramus (cms)			
Mandibular length (cms)			

SOMATOSCOPY

Introduction

When you look around yourself casually, did you realise how much information you get of a person just at a glance? It is incredible to discover so much has been received and retained by your brain about physical features, clothes etc. of a person. Be it colour of hair, height, physique, type of nose, shape of the face, etc. are just registered in fraction of a second. This very perception plays a very important role in identifying a person; be it the case of investigation or racial classification. There are many physical traits which cannot be easily measured; these are best observed and described qualitatively. Most somatoscopic traits show marked geographical variation.

Somatoscopy concerns the systematic visual observation of physical features of various parts of human body for accurate description. These are qualitative in nature, hence descriptive in approach. To standardise the approach, many charts have been prepared by different scholars for determining the colour of hair, skin, eye, etc. Not only that, these charts are not available, but most of the features are described by simple descriptive terms which have actually become standard.

Skin colour: Did you realise that our skin colour is not uniform all over the body, number of physiological factors like area of arterial or venous blood supply and environmental factors like exposure to sunlight are related to the expression of skin colour. There is difference in the skin colour of exposed and unexposed part of our body. The skin shows two types of pigmentation, one is inherited and the other is climatic (which is tanned due to exposure). Therefore, skin colour is considered at two sites; forehead or cheek (exposed to sun) and inner side of the upper arm (unexposed to sun).

Broca (1865), Luschan (1916), Hintze (1927) and Fritsch (1916) have given different colour charts and the skin colour is determined in consultation with these charts. In the absence of these charts, the skin colour is described using descriptive terms like light yellow brown or dark brown or pale white, etc. In reality, skin colour depends on the quantity of melanin pigment and the skin colour is best understood by the variants of brown like light brown, medium brown and dark brown with medium brown having the maximum variety. The skin colour should be observed in normal daylight not in direct sunlight.

Hair colour and form: When you are looking at anybody's head hair so many features come into note. These are the colour, quantity, form; texture all forming components of somatoscopy. Hair is mostly studied for colour and form. Fischer and Saller (1928) have used natural hair to make hair colour chart. The colour of the hair should be examined in natural light. Care should be taken that colour is not dyed, in such cases the colour at root hair is to be taken as the colour of the hair. The colour of the hair is affected by age, oil and perfume too. Among the Indians the range of the hair colour would be categorized as light brown, medium brown, dark brown and black.

As far as hair form is concerned it can be broadly categorized as straight, wavy and woolly hair. Now straight hair can be stretched, smooth or flat wavy; Wavy hair can be broad wavy, narrow wavy, curly wavy; and Woolly hair can be frizzly, widely knit, closely knit, filfil or spiral.

Pluck the hair from the scalp, it gives the right observation.

Eyes: Eyes play an important role in looks of any person. Somatoscopic features considered in case of eyes are colour of the iris, eye fold and direction of the eyes. The colour of the eye (actually the iris) has been described in various charts. It varies from black brown or dark brown or brown or light brown or greenish or grey or light grey or dark blue or blue or light blue or crimson red. As far as eye folds are concerned they are present or absent. Horizontal, slanting (downward) or oblique (upward) describe the direction of the eye. To get best results, stand 1-2 feet away from the subject in such a manner that the subject gets enough light on the eyes and avoid direct sunlight.

Nose: There are number of morphological features of nose. Simple descriptive terms are used to describe nose parts like root, bridge, septum, tip and wings. The tip of the nose can be upwards or downwards and the profile could be rounded at point or fully rounded or flat. The root of the nose can be recorded as narrow, medium or broad; from the side view may appear depressed which again may be shallow, medium or deep or absent. The nasal bridge may be recorded as straight, concave-slight, medium, markedly, convex- slight, medium, markedly or wavy-slight, medium, markedly. The size of the nasal bridge may be narrow, medium or broad.

Lips: The thickness of the membranous lip is studied with best observations in profile view. It may be thin, medium, thick and puffy or everted. Now what is an everted lip? The upper membranous lip is puffy with convex profile, above which the integument lips are deeply concave.

Face: Size- height of the face (long, medium or short) and diameter of the face (narrow, medium, broad or very broad), shape, malar prominence and prognathism are used to describe face. The shape can be oval or elliptical, round or square or quadrangular or flat. Prominence of the cheek bone (malar) is an important feature; it is described as absent, slight, moderate or marked. Alveolar protrusion of face is called prognathism. Profile view is best to ascertain it to be slight, moderate or marked.

PRACTICE 1

Record the somatoscopy observation on eight people for following traits

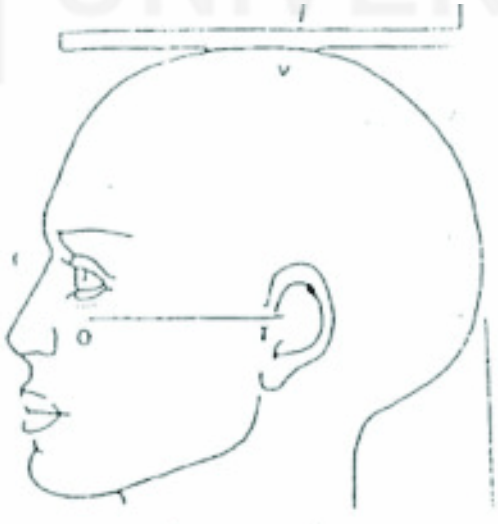
Somatoscopy trait	1	2	3	4	5	6	7	8
Skin colour								
Hair colour								
Hair form								
Eye colour								
Eyefold								
Eye direction								
Nose root								
Nasal bridge								
Nasal septum								
Nose tip								
Nasal wings								
Lip thickness								
Face size								
Face diameter								
Face shape								
Face prominence of cheekbone								
Face prognathism								

SOMATOMETRY

Somatometry is made of two words 'somato' which means living and 'metric' which refers to measurement, so in simple terms it means measurement of living beings. Therefore, Somatometry a division of anthropometry is defined as a systematic technique to measure living body including head and face. Anthropologists have formulated number of measurements for describing the morphology of man. These measurements are not arbitrary but are based on anatomical landmarks and have been in use for hundreds of years. They are useful in comparing various kinds of men living in different geographical regions, i.e., for racial comparisons or to study variations in body types. Physical growth of children is studied on the basis of their body measurements. The nutritional status of young and adults is also assessed with the help of these measurements. It also facilitates in the determination of certain physiological functions like vital capacity, basal metabolic rate, etc. Data generated on the basis of anthropometry surveys of populations has been an asset for designing proper equipment for use in industry and defence purposes, spaceships, garments, etc. The anthropometric surveys also provide norms of the physique of any population and trends of changes in morphological traits.

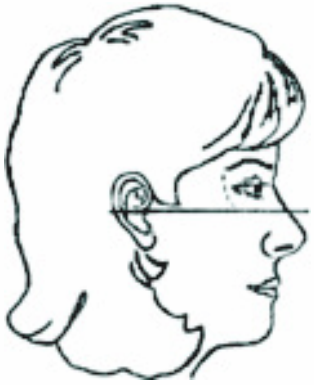
Techniques

Minimum clothes by the subject should be worn while taking the measurement as it will facilitate in locating the landmarks. There are certain positions in the human body which hold importance while taking measurements. Frankfort horizontal plane is one of them. Frankfort Horizontal plane was established in 1984 at the World Congress on Anthropology in Frankfurt, Germany. This plane is used to orient a human skull or head such that the plane is horizontal. E*ye-ear plane, Frankfort horizontal, Frankfort plane are its other names.* It is a horizontal plane which is characterised in profile by a line which is the lowest point on the margin of the orbit of the eye (lower margin of the left orbit) and the highest point on the margin of the auditory meatus (External auditory canal).



ORBITALE: Lower margin of eye socket
TRAGION: Notch above tragus of ear or at upper margin of zygomatic bone at that point
FRANKFORT PLANE: Orbitale-tragion horizontal line

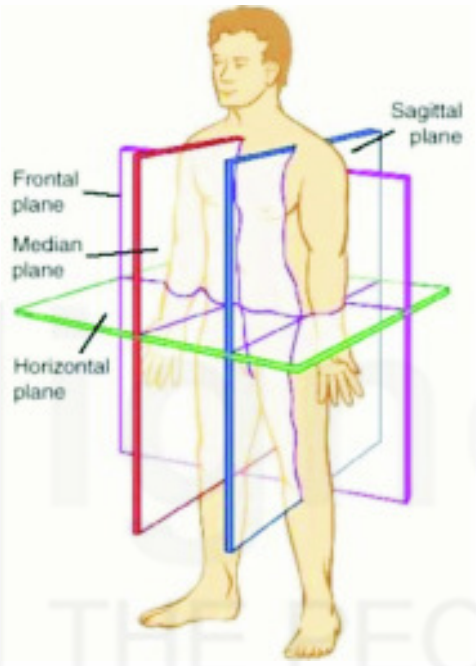
Source: www.jsn.sagepub.com



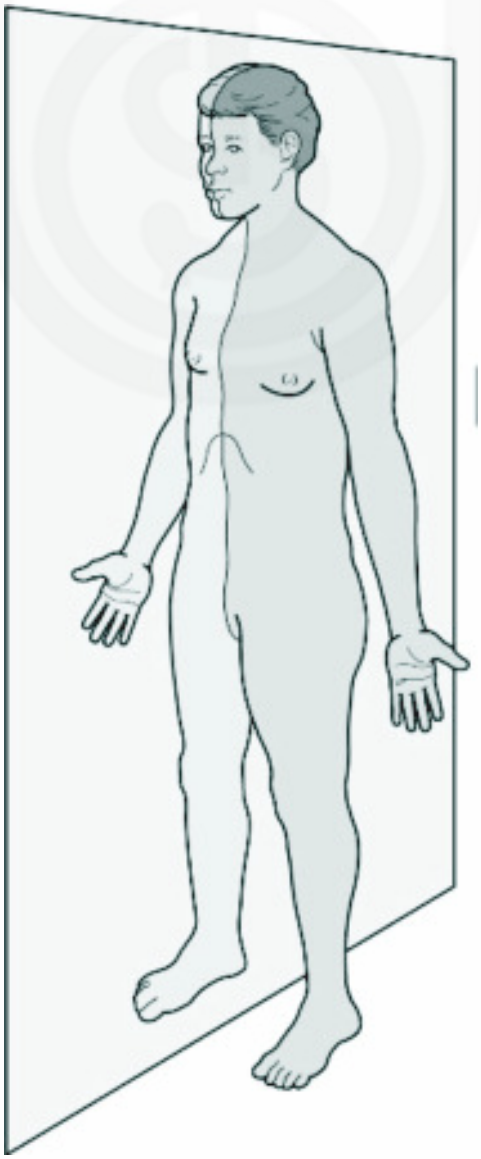
Source: www.isn.sagep46.com

The head of the subject should rest without any strain in the eye-ear plane or F-H plane i.e. tragion and right orbitale must lie in the same plane. All measurements except those concerning mid sagittal plane should be taken on the right side of the body because it is easier to work with instruments with right hand. Some researchers have recommended all measurements except those involving the mid-sagittal plane should be taken on left side of the body in order to avoid any occupational exaggeration or deformity.

Mid-Sagittal plane is vertical plane which passes through the body in such a way that it is parallel to the median plane. Median plane is a plane which passes longitudinally through the middle of the body from front to back in such a way that it divides the body into right and left halves. This figure shows the different planes of human body.



Source: www. img.tfd.com

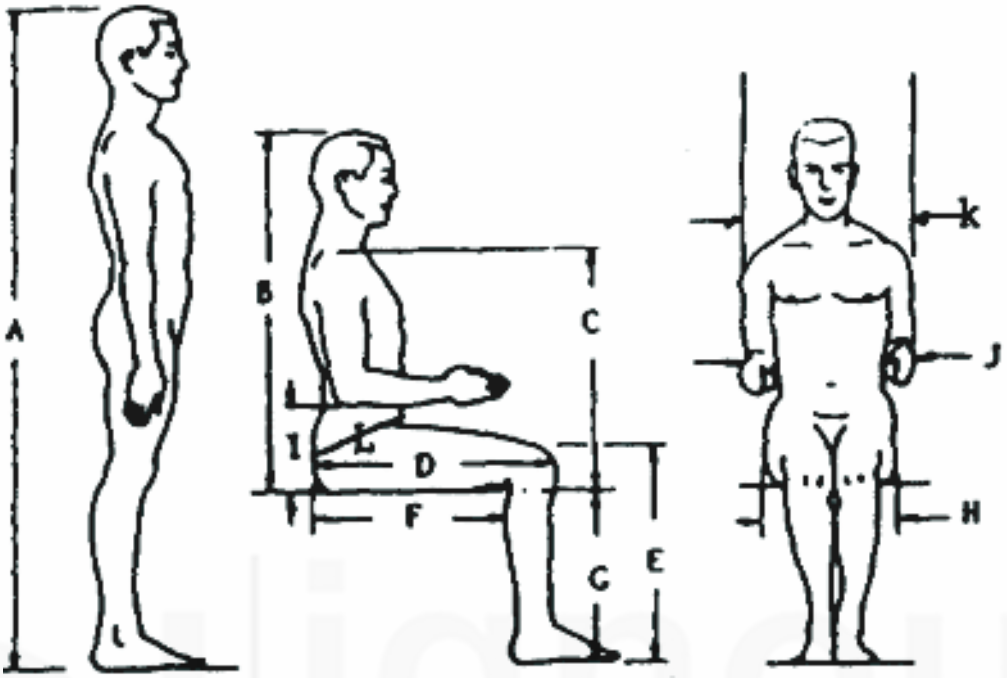


Mid sagittal plane

Source:www.img.tfd.com

For each measurement taken certain precautions need to be followed which have been mentioned in method of measurements.

Standard positions



Source: www.keywordpicture.com

PRACTICE 1

Record the following measurements on four subjects

Body weight

Stature

Sitting height

Head length

Head breadth

Bizygomatic breadth

Body weight: Weight should be taken by means of standard weighing machine with fine accuracy. The weight should be taken with minimum clothes and barefoot. Body weight is measured in kilograms, which gives an idea of body mass.

Instrument: Weighing machine

Method: Adjust the needle of the weighing scale to remove the zero error.

Ask the subject to stand with equal weight on both the feet. The head of the subject should be forward. Note the reading on the weighing scale when the needle is stationary.

Precautions: Take care that the subject is wearing minimum number of clothes.

Weight should not be taken right after taking meals.

Make proper adjustment for clothes worn by the subject at the time of taking weight.

It is recommended that at the time of recording weight of the clothes should also be noted.

Stature (floor-v): It measures the vertical distance from the standing floor to the vertex.

Vertex (v): It is the highest point on the head when the head is in the Frankfurt-Horizontal (FH) plane, also known as eye-ear plane. Vertex is not an anatomically fixed point and is dependent on the orientation of the head.

Instrument: Anthropometer

Method: Ask the subject to stand erect, barefoot on a level floor against the wall with her/his back and buttocks touching the wall. Take care that the heels are touching the wall and toes are at an angle of 45° to each other. The shoulders should not be raised upwards. The arms should be in standard arm hanging position and the palms of the hands should touch the thighs. Place the anthropometer rod on the back of the subject if the vertical wall is not available. The head of the subject must rest without any strain in the eye-ear plane or FH plane, i.e., tragion and the right orbitale must lie in the same horizontal plane. Now with the position of the subject set, you stand on the right side of the subject with anthropometer in the median sagittal plane of the subject and allow moving cross-bar to touch the vertex lightly. Note that the anthropometer is in vertical position.

Precautions: The subject is barefoot.

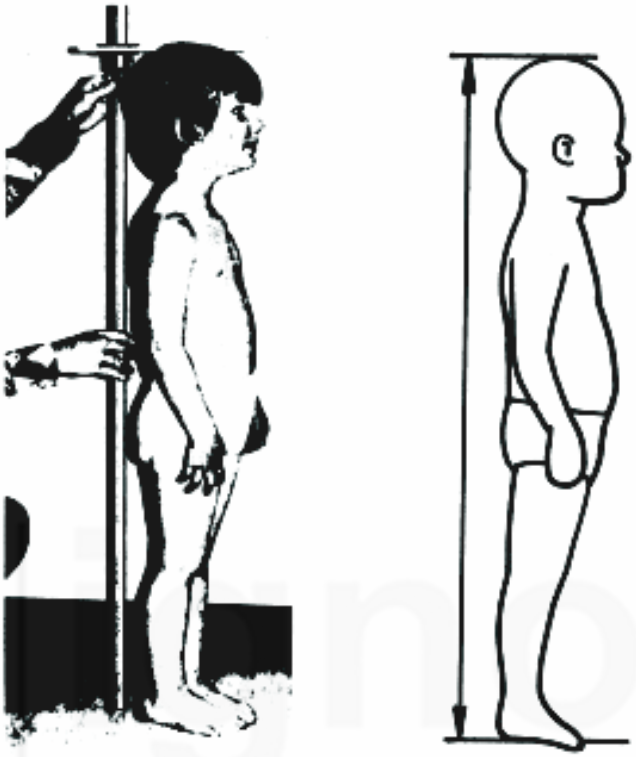
The heels, back and buttocks of the subject should touching the wall.

The toes are at an angle of 45°.

The arms should be in standard arm hanging position.

The head of the subject should be in eye-ear plane.

The face of the subject should be stretched adjusting the mastoid process.



Source: www.ovrt.nist.gov

Sitting height (sitting surface-v): It is the vertical distance of the vertex from the plane of sitting surface of the subject when stretched i.e., when the vertebral column is stretched to the maximum. .

Vertex (v): It is the highest point on the head when the head is in the Frankfurt-Horizontal (FH) plane, also known as eye-ear plane. Vertex is not an anatomically fixed point and is dependent on the orientation of the head.

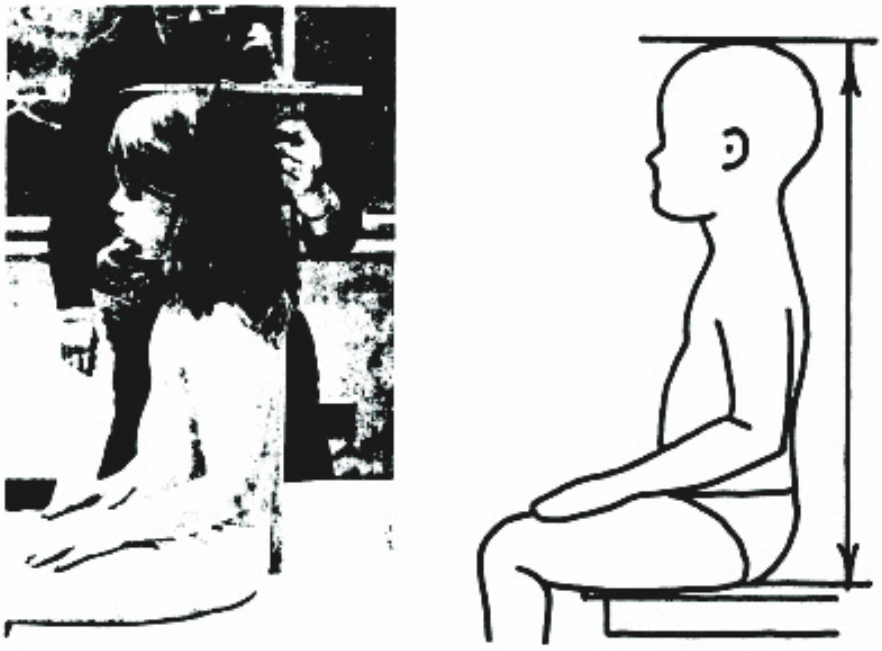
Instrument: Anthropometer

Method: Ask the subject to sit on a horizontal surface preferably on a table 30-40 cms high. Orient his/her head in eye-ear plane and the body stretched to the maximum. Note that the shoulder should run parallel, the thighs should be almost horizontal and the legs hanging from the table with back of the knee touching the vertical surface of the table and also don't allow the knees to bend. The hands should rest on the thighs with palms facing down. Anthropometer should be held at the back of the subject aligned to the vertebral column and bring down the movable cross bar on to the vertex and note the reading.

Precautions: The subject should be sitting erect with legs hanging freely from the table at an angle of 90°.

Head should be oriented in eye-ear plane.

The hands should be resting with palm facing the thighs.



Source: www.ovrt.nist.gov

Head length (g-op): It is the linear distance between glabella(g) and opisthcranion (op) i.e. the most projecting point on the dorsal surface of the head in the mid-sagittal plane.

Glabella (g): It is the point on the protuberance of the lower forehead above nasal root and between the eyebrow ridges intersected by mid-sagittal plane i.e., it is the most anterior point in the median plane between the eye brows.

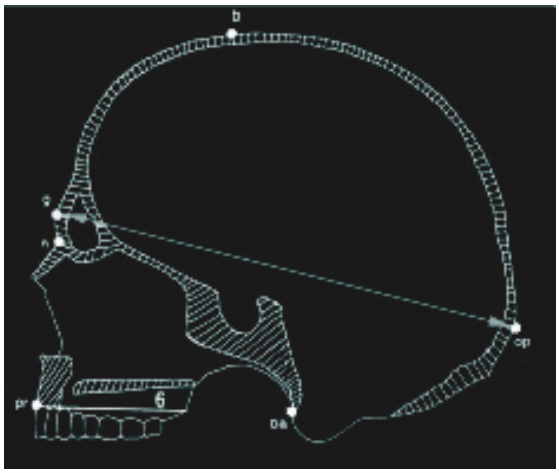
Opisthcranion (op): It is the most posterior point on the posterior protuberance of the head in the mid-sagittal plane i.e., it is the point on the back of the head, farthest away from the glabella in the median plane. It is not an anatomically fixed point.

Instrument: Spreading caliper (with blunt ends), skin marking pencil.

Method: Hold the left arm of the caliper on the glabella and move the right arm up and down on the back of the head in the mid sagittal line, till you get the maximum reading in the scale. That is the maximum head length.

Precautions: Hold the instrument in such a manner that the tips of the caliper are free to touch the head.

Undue pressure should not be applied while taking the measurements.



Source:www.theapricity.com

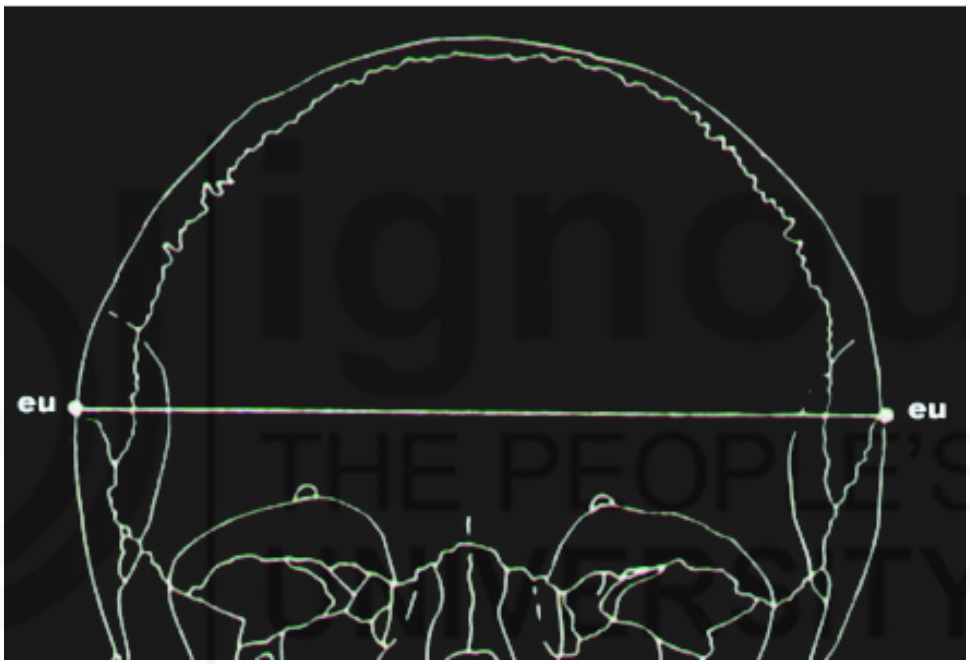
Head breadth (eu-eu): It measures the straight distance between the two eurya (eu), i.e., maximum breadth taken at right angles to mid-sagittal plane wherever found.

Euryon (eu): It is the lateral most point on the lateral wall of the head, i.e. sides of the head. Again it is not an anatomically fixed point.

Instrument: Spreading caliper with blunt ends.

Method: Stand behind or in front of the subject and hold the arms of the spreading caliper in such a manner that the joint of the caliper is in the mid-sagittal plane of the head. Now slide the tips of the caliper from forward to backwards and vice versa in zigzag manner starting with smaller and gradually to bigger circles till you get maximum reading on the scale.

Precautions: Note that the line joining the tips of the caliper must be at right angles to the mid-sagittal plane.



Source: www.theapricity.com

Bizygomatic breadth (zy-zy): It measures the straight distance between the two zygia (zy) landmarks i.e., the most lateral points on the zygomatic arch. The greatest breadth of the zygomatic arch is found near the ear and not on the cheek.

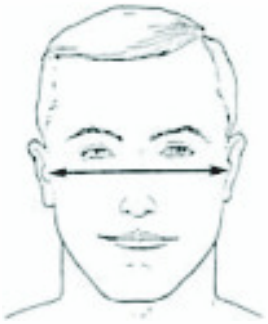
Zygion (zy): It is the lateral most point on the zygomatic arch, one on each side. Anatomically it is not a fixed point.

Instrument: Spreading caliper with blunt ends.

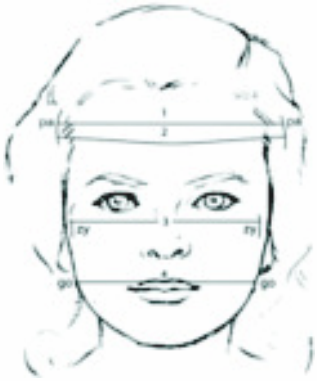
Method: Hold the two tips of the arms of the caliper between the thumb and first finger, about 2 cms away from the tragus and slide the tip slowly over the zygomatic arch in such a manner that the thumb touches the upper margin and the first finger the lower margin of the zygomatic bone. Record the maximum reading.

Precautions: Note that the skin has not been displaced while recording the measurement.

The joint of the caliper must lie in the mid-sagittal plane.



Source:www.amazonaws.com



Source:www./ejo.oxfordjournals.org

Practice 1

Measurements (landmarks) (units)	Subject 1	Subject 2	Subject 3	Subject 4
Body weight (kg)				
Stature (floor-v) (cms)				
Sitting height (table surface-v) (cms)				
Head length (g-op) (cms)				
Head breadth (eu-eu) (cms)				
Bizygomatic breadth (zy-zy) (cms)				

PRACTICE 2

Record the following measurements on four subjects.

Nasal length

Nasal breadth

Nasal height

Biacromial breadth

Bitrochanteric breadth

Nasal length (n-prn): It is the straight distance between nasion to pronasale.

Nasion (n): It is the point on the nasal root intersected by mid-sagittal plane. Nasal root is not the depression of the nose but at the intersection of inter-nasal suture and fronto-nasal suture which can be felt by slightly probing the root of the nose. i.e., just apply a moderate pressure below your glabella and you will notice a sharp kink. Note that nasion usually lies in the level of the medial end of the eye-brows mostly on the lower margins and not at the height of the eye-brows.

Pronasale (prn): It is the most anteriorly placed point on the tip of the nose in the mid-sagittal plane.

Instrument: Sliding caliper (with blunt ends), skin marking pencil, spirit, cotton.

Method: Place the fixed end of the caliper on the nasion. Slide the movable end of the crossbar on the pronasale and record the reading.

Precautions: Note the two landmarks are in the mid-sagittal plane.

Nasal breadth (al-al): It is the straight distance from one alare to the other alare, i.e., the most lateral points on the nasal wings.

Alare (al): It is the lateral most point on the outer surface of the nasal wing on either side.

Instrument: Sliding caliper (with blunt ends).

Method: Hold the caliper transversely, right. Now hold the fixed crossbar of the caliper on the outer surface of the right nasal wing of the subject, supported by your left index finger, and touch the left nasal wing with the movable crossbar. Record the reading on the scale.

Precautions: Take care that you don't press the wings too much with the caliper.

Take the reading when the subject is breathing normally.

Nasal height (n-sn): It measures the straight distance between nasion and subnasale.

Nasion (n): It is the point on the nasal root intersected by mid-sagittal plane. Nasal root is not the depression of the nose but at the at the intersection of inter-nasal suture and fronto-nasal suture which can be felt by slightly probing the root of the nose, i.e., just apply a moderate pressure below your glabella and you will notice a sharp kink. Note that nasion usually lies in the level of the medial end of the eye-brows mostly on the lower margins and not at the height of the eye-brows.

Subnasale: It is the point where the lower margin of the nasal septum (between the nostrils) meets the integument of the upper lip. This point should be sought where the tangent drawn to the nasal septum meets the upper lip.

Instrument: Sliding caliper (with blunt ends), skin marking pencil, spirit, cotton.

Method: Hold the sliding caliper in your right hand in such a manner that the lower arm of the caliper touches subnasale and the upper arm of the caliper is held between thumb and first finger on nasion.

Precautions: Note the nasion is in the mid-sagittal plane.

Biacromial breadth (a-a) It measures the straight distance between the two acromion landmarks.

Acromion (a): It is the most lateral point on the lateral margin of the acromial process when the subject stands in normal position with his arms hanging by the sides. Trace with index finger along the spine of the scapula unto the lateral edge of the acromial process i.e., from sternal end to lateral wards, take the most lateral point.

Instrument used: Rod compass (the first segment of Anthropometer with adjusted crossbars), skin marking pencil.

Method: Stand behind the subject. Now locate the acromion and place the inner side of the fixed crossbar on one acromion while sliding casket with crossbar is drawn and placed on the other. The landmarks are located by palpating with the first fingers while the other fingers hold the cross-bars.

Precautions: The subject should be standing erect.

Note that the subject keeps his shoulder straight.

Bitrochanteric Breadth (tro-tro): It is also known as hip breadth and measures the straight distance between the two trochanterion landmarks.

Trochanterion(tro): It is the highest and most laterally placed point on the greater trochanter of the femur. Now how do you locate it? Ask the subject to move the legs forward and backwards. Then place your fingertips of both hands on the subject's thighs. The point that appears to move with the movement is trochanterion.

Instrument: Rod compass.

Method: Stand behind the subject who is standing erect and hold the rod compass horizontally. The trochanterion on both the sides are located by using fingertips of both the hands. Place the rod compass on both the points and note the reading.

Precautions: The feet should touch each other.

Weight of the body should fall equally on both the feet.

Practice 2

Measurements (landmarks) (units)	Subject 1	Subject 2	Subject 3	Subject 4
Nasal length (n-prn) (cms)				
Nasal breadth (al-al) (cms)				
Nasal height (n-sn) (cms)				
Biacromial breadth (a-a) (cms)				
Bitrochanteric breadth (tro-tro) (cms)				

PRACTICE 3

Record the following measurements on four subjects.

Chest circumference

Upper arm circumference

Calf circumference

Skinfold at biceps

Chest circumference: It measures the circumference of the chest of the subject when the subject is breathing normally.

Instrument: Flexible Steel Tape

Method: Raise the arms of the subject before fixing the tape around the chest. Hold the tape horizontally at the level of nipples passing over the lower angle of scapula. The arms should rest normally while taking the measurements. Incase of females, circumference at the base of xiphoid processes horizontal to the thorax may be taken.

Precaution: Note that the shoulders are not bending too much forwards.

The tape should be horizontal.

Upper arm circumference: It measures the circumference of the upper arm in the middle.

Instrument: Flexible Steel Tape

Method: Ask the subject to hang the hand freely in standard arm hanging position. Place the tape horizontally around middle of the upper arm where generally the bicep muscles are most developed and record the reading.

Precaution: The arms should be hanging freely.

The tape should neither be tightly nor loosely held.

Calf circumference: It measures the circumference of the calf around the most developed area of the calf muscles.

Instrument: Flexible Steel Tape

Method: Ask the subject to stand and keep the tape horizontal around the most developed portion of the muscle of the calf to obtain the value.

Precaution: The legs should be straight.

The tape should neither be tightly not loosely held.

The tape should be horizontal.

Skinfold at biceps: It measures the skinfold thickness at the front of the upper arm at the level marked for taking the upper arm circumference. Pick up the skin fold with your thumb and index finger directly above the centre of cubical fossa. Then apply the skinfold caliper jaws and record the measurement.

Instrument: Skinfold caliper.

Method: Ask the subject to stand with the arms hanging freely on the sides of the body. Stand in front of the subject, lift a vertical fold with your thumb and index finger one centimeter above the mid upper arm circumference. Place the jaws of

the caliper on the folds and record the reading in mm. The reading is recorded when the needle comes to a standstill approximately within a seconds of applying the caliper.

Precaution: Take care not to prolong the time of the application of the caliper to the skin because prolongation causes the displacement of the fat, and hence change in the reading.

The hold of the pinch above the skinfold should not be loosened while taking the measurement.

If the subject feels pain at the application of the caliper, withdraw it immediately.

The subject feels pain when the muscle is also pinched along with the subcutaneous fat.

Practice 3

Measurements (landmarks) (units)	Subject 1	Subject 2	Subject 3	Subject 4
Chest circumference (cms)				
Upper arm circumference (cms)				
Calf circumference (cms)				
Skinfold at biceps (mm)				

PRACTICE 4

Calculate the following indices on the measurements taken earlier.

Cephalic index

Nasal index

Cephalic index: It is the percentage ratio of maximum head breadth per unit maximum head length.

Cephalic index (C.I.): $\frac{\text{Head Breadth}}{\text{Head Length}} \times 100$

Classification

Category	Range	
	Male	**Female**
Hyperdolichocephalic :	X-70.9	X-71.9
Dolichocephalic :	71.0-75.9	72.0-76.9
Mesocephalic :	76.0-80.9	77.0-81.9
Brachycephalic :	81.0-85.4	82.0-86.4
Hyperbrachycephalic :	85.5-90.9	86.5-91.9
Ultrabrachycephalic :	91.0 +	92 +

Nasal index: It is the percentage of nasal breadth per unit nasal length.

Nasal Index **(N.I):** $\frac{\text{Nasal Breadth}}{\text{Nasal height}} \times 100$

Classification

Category	Range
Hyperleptorrhine	X-54.9
Leptorrhine	55.0 -69.9
Mesorrhine	70.0 -84.9
Chamaerrhine	85.0 -99.9
Hyperchamaerrhine	100 +

Practice 4

Index	Subject 1	Subject 2	Subject 3	Subject 4
Cephalic index				
Nasal index				

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Suggested Reading

The list is given at the end of unit 4.

UNIT 3 PHYSIOLOGICAL VARIABLES

Introduction

Physiological anthropology is connected to physical anthropology and is concerned with the uniqueness that relate to biology. It focuses to elucidate human physiological features, in a wide sense. Seen in this viewpoint, physiological anthropology belongs to the basic natural sciences. It flourishes on living organisms that vary in many different ways. Living organisms, in the process of evolution, have differentiated in many different directions up to the current day. And within the same species, as individual specimens or in groups, they have come to have widely varying functional, morphological and behavioral characteristics which only physiological anthropology takes into account. The second different aspect of physiological anthropology is that the objects of study of physiological anthropology are we ourselves, human beings, who have unique physiological functions compared to other animals in nature. In short, this refers to very highly developed mental abilities and it is impossible when studying human beings in a comprehensive way to overlook the existence of these distinctive abilities. Physiological anthropology is an area focused on the understanding of human nature and behavior in reference to their environment based on physiological mechanisms. These biological roles which are based on behavioral physiological mechanisms have a constructive effect for the living being resulting as being a form of "adaptation".

Some adaptations might lead to frequent complaints pertaining to body problems, basically physiological in nature such as low or high blood pressure, obesity etc. Such problems have become very common. Blood pressure can be defined as the pressure exerted by blood on the arterial wall. What happens is that with each ventricular beat i. e. when left ventricle contracts, blood enter the aorta which is already filled with blood. As more and more blood enters the aorta, the blood flow exerts pressure on the elastic arterial wall. This pressure is called 'blood pressure'. Most people have had their blood pressure checked at some point of time, either due to curiosity or on a visit to clinician for some discomfort, isn't it? You must have seen that it is simple and quite painless procedure, yet gives vital information about our heart and the condition of the blood vessels.

Now, what is measured while taking blood pressure? Well it is the maximum pressure (systolic) and the lowest pressure (diastolic) made by the beating of the heart that is measured. The question what is the maximum or systolic pressure and what is the minimum or diastolic pressure. The systolic pressure is the maximum pressure in an artery at the moment when the heart is beating and pumping blood through the body. The diastolic pressure is the lowest pressure in an artery in the moments between beats when the heart is resting. Both the systolic and diastolic pressure measurements are important – if either one is raised i.e., more than the standard value one is said to have high blood pressure or hypertension. How do you measure the blood pressure? Sphygmomanometer is the answer.

Sphygmomanometer

A sphygmomanometer or blood pressure meter is a tool used to measure blood pressure particularly in arteries, made up of an inflatable cuff, the function of

which is to restrict blood flow, and a mercury or mechanical manometer to measure the pressure. The fundamental behind it is that it is always used to record reading at the time when blood pressure flow has just started and at what pressure it is unimpeded. Stethoscope is prerequisite while using manual sphygmomanometers.

The word sphygmomanometer comprises of two Greek words 'sphygmós' meaning the beating of the heart or the pulse and a scientific word manometer refers to device for measuring pressure or tension. The credit of inventing sphygmomanometer goes to Samuel Siegfried Karl Ritter von Basch in 1881, although it was Scipione Riva-Rocci, an Italian physician who introduced a more easily used version in 1896. However, popularity of this device increased only in 1901 after being discovered by Harvey Cushing. Joseph Erlanger (1874-1965), an American physiologist studied the principles of sphygmomanometry and devised a recording sphygmomanometer. There are two types of manual sphygmomanometers available; one with a mercury column and a gauge with a dial face, but the sphygmomanometer which is most frequently used today consists of a mercury manometer serving as a measuring unit and inflation bulb and valve i.e., a gauge is attached to a rubber cuff wrapped around the upper arm and is inflated to constrict the arteries.

There are three versions of sphygmomanometers available:

Manual sphygmomanometers: Manual sphygmomanometers are most ideal and conventional device to measure the blood pressure; as they are unfailingly accurate. Since their reliability quotient is very high they are ideal for monitoring blood pressure for high risk patient and also pregnant women. The unit of measurement of blood pressure is millimeters of mercury (mmHg) and is usually calibrated in an even number. Stethoscope usage is mandatory incase of manual sphygmomanometers auscultation (listening to sounds within the body using a stethoscope), because only systolic blood pressure is recorded through palpation.

Clinical Mercury Manometer

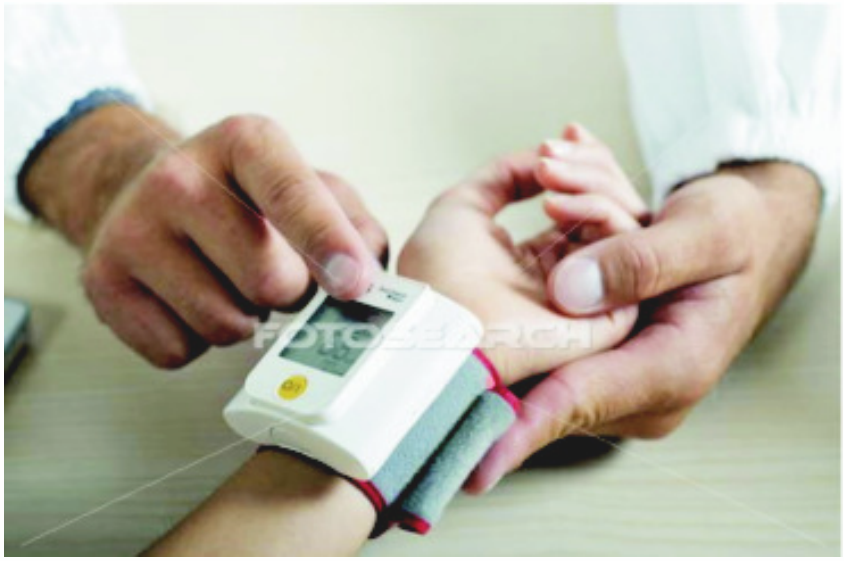
Source: 1

Digital with manual or automatic inflation: This is an electronic device, easy to manage, and functional in noisy environments. It works on the principle of measuring mean arterial pressure [Mean arterial pressure (MAP) is a term used in medicine to describe an average blood pressure in an individual during a single cardiac cycle] and use oscillometric detection to calculate systolic and diastolic values. This is an indirect way to measure the blood pressure, since it derives the readings. Digital oscillometric monitors have their own limitations as they cannot be used in certain conditions like arteriosclerosis, arrhythmia, preeclampsia, pulsus alternans and pulsus paradoxus.

Digital portable sphygmomanometers: These sphygmomanometers are portable hence easier to operate but are comparatively less accurate.

Source: www.wikimedia.org

Wrist cuff blood pressure monitors are also in use but are found to be quite erroneous, and the monitor has to be at the level of the heart when recording the reading. These are the smallest blood pressure monitors, and are finger blood pressure monitors having automatic inflation.



Source: u17052091 fotosearch.com

Stethoscope

The term stethoscope is derived from Greek word 'stéthos' which means chest and 'skopé' meaning examination. It is an acoustic medical device used in medical application for audio purposes for auscultation, i.e., listening to the internal sounds of the body. Its application comprises listening to lung, heart sounds, intestines and blood flow in arteries and veins. When in combination with a sphymomanometer, it is commonly used in measuring the blood pressure. You would be surprised to know that "mechanic's stethoscopes" are used to listen to internal sounds made by machines, such as diagnosing a malfunctioning automobile engine by listening to the sounds of its internal parts and also to check scientific vacuum chambers for leaks, and for various other small-scale acoustic monitoring tasks.

Source: www.lotusoverseas.com

Let's see how sphygmomanometer functions. First of all we must know that the sphygmomanometer measure two readings of blood pressure: systolic and diastolic blood pressure. Systolic blood pressure refers to systole; this is the phase when the heart pumps blood out into the aorta or we can say it the measure of pressure exerted by the blood on the wall of the vessel during each contraction of the ventricular muscle and diastolic blood pressure refers to diastole, the resting period when the heart refills with blood as blood fills up the aorta, the pressure which remains in the arteries during the relaxation of the heart. It means that with each heartbeat, blood pressure is raised to the systolic level, and between beats, it drops to the diastolic level. The blood pressure is measured in 'mmHg' units by observing the mercury in the column when the air pressure is released using a control valve. The peak pressure or the maximum pressure in the arteries during the cardiac cycle is the systolic pressure, and the lowest pressure that is at the resting phase of the cardiac cycle is termed as diastolic pressure. Systolic

pressure (first phase) is identified with the starting or first of the continuous Korotkoff sounds whereas the diastolic pressure is identified at that moment when the Korotkoff sounds disappear (fifth phase). A stethoscope is used in the auscultatory method.

The question arises, how do you measure the blood pressure?

To start with the subject has to be in relaxed comfortably seated position with arms well supported. It can also be taken while lying down, and then it is called in supine position. Always remember that blood pressure is measured by inflating a cuff around the arm. Tie the cuff around the upper arm of the subject and keep it in place using Velcro. The cuff is generally tied smoothly and snugly around an upper arm, at the same height as the heart when the subject is seated with the arm supported. There is a tube attached to the cuff which connects the rubber bulb. The cuff is inflated till the artery is completely occluded. When the cuff is inflated with air, a stethoscope is placed over the brachial artery in the crook of the arm. When the pressure in the cuffs falls, a "whooshing" or pounding sound is heard called as Korotkoff sounds, this is the situation when blood flow first starts again in the artery. The moment the air in the cuff is released, the very first sound audible through the stethoscope symbolizes the systolic pressure. As the release of air from the cuff continues there comes a point when the sound diminishes and then one can no longer hear it. The point where the sound disappears is considered to be the diastolic pressure. Thus, the blood pressure reading recorded represents the systolic and diastolic pressures. When we say that blood pressure is 120/80 then means 120 and 80 mm of mercury (Hg) respectively with 120 denoting systolic blood pressure and 80 denoting diastolic blood pressure. A typical blood pressure said to be normal for an adult is 120/78. This reading varies with age and influenced by many other factors.

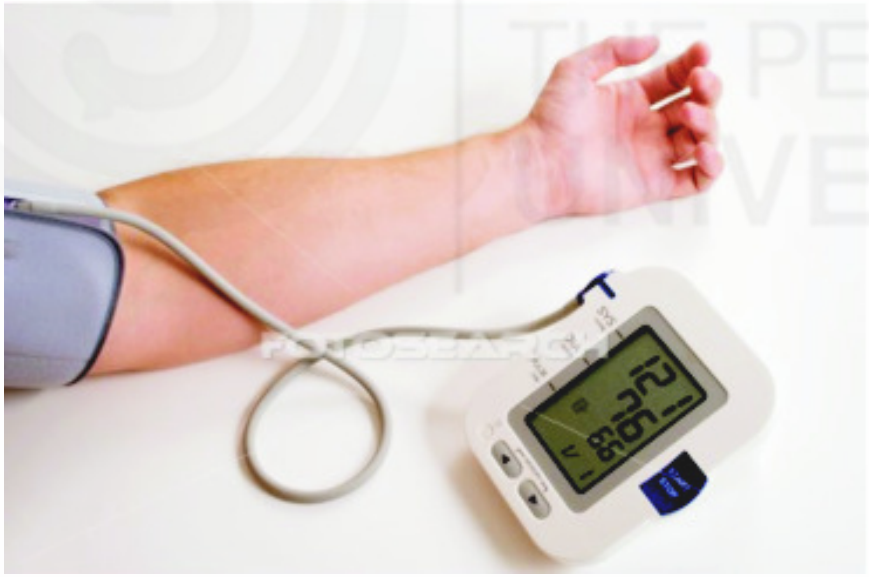
The seventh report of Joint National Committee in 2004 on prevention, detection, evaluation and treatment of blood pressure has given the following standards for blood pressure:

Category	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
Normal	< 120	< 80
Pre-hypertensive	120-139	80-89
Hypertensive	> 140	> 90

Measuring Blood Pressure

Source: pe0062147 fotosearch.com

Source: bld061575 fotosearch.com



Source: k0415478 www.fotosearch.com

These days' electronic measuring devices are commonly found to be used by people at their home to measure blood pressure (since mercury is being phased out because of its hazardous nature). They are found to be accurate enough for routine clinical use, more users friendly and are relatively inexpensive. The chances of errors in blood pressure measurement that human beings can generate are reduced.

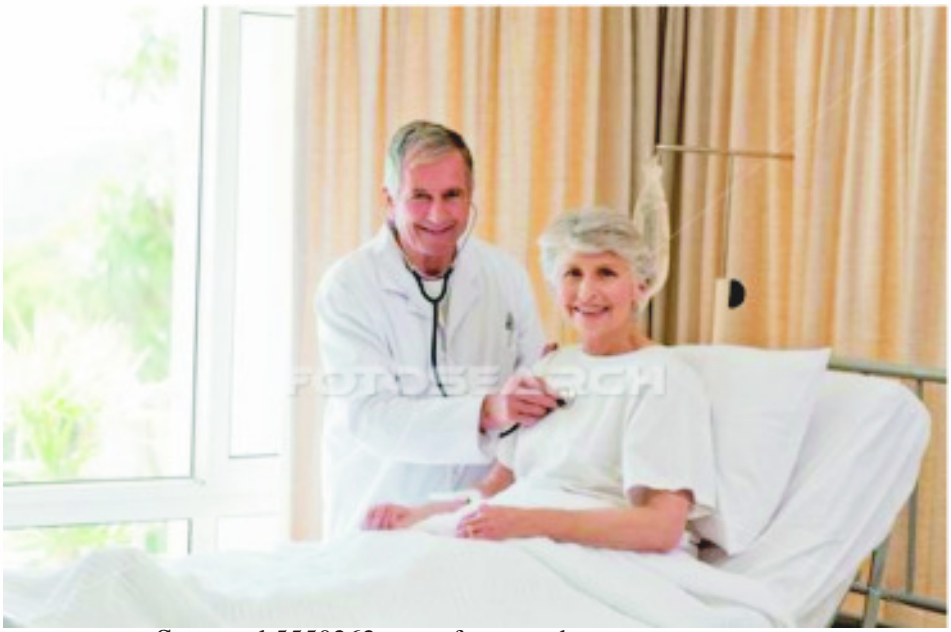
Ambulatory blood pressure monitoring (ABPM) entails measuring the blood pressure for 24 hours during the daily routine and even during sleep. In this, the

device measures the blood pressure at regular intervals. The readings are recorded on a chip in the device and give a detailed picture of blood pressure variation in a normal environment. Ambulatory blood pressure monitoring is advised when high blood pressure is resistant, that is no reaction to drug treatment – three or more drugs or help in the identification of high blood pressure related to anxiety in the clinical setting, known as 'white coat hypertension' or when the blood pressure is showing atypical variation or probably when symptoms suggest the possibility of low blood pressure due to over-treatment.

Measuring Heart Rate

If you know how to measure your heart rate or pulse, it facilitates in learning about your own level of fitness and detect potential medical problems that should be brought to the attention of your physician incase of an irregular reading. What is Heart Rate? As the name suggests it is number of times heart beats in a minute measured by feeling your pulse. It is the rhythmic expansion and contraction (or throbbing) of an artery as blood is forced through it by the regular contractions of the heart. It is a measure of how hard your heart is working by feeling the pulse.

Source: px265058 www.fotosearch.com



Source: k5550262 www.fotosearch.com

Heart rate is defined as the number of ventricular beats per minute. The heart rate can be recorded at any point on the body at which an artery is close to the surface and a palpitation can be experienced. The most common places to measure heart rate using the palpation method is at the wrist (radial artery) and the neck (carotid artery). Elbow (brachial artery) and the groin (femoral artery) are also sometimes used. Always remember to use your fingers to take a pulse, not your thumb. This is particularly when recording someone else's pulse, because sometimes you feel your own pulse through your thumb. How do you record the heart rate?

Manual Method

Carotid Pulse (neck) – In this case when heart rate is taken at the neck, the first two fingers on either side of the neck are positioned, and the number of beats for a minute is then counted.

Radial Pulse (wrist) – Radial pulse rate involves index and middle fingers together to be placed on the opposite wrist, about $^1/_2$ inch on the inside of the joint, in line with the index finger. As soon as pulse is felt, number of beats felt within a one minute period is counted.

Monitor Method

A heart rate monitor is often used to get a more precise heart rate measurement. This holds significance particularly during exercise where the motion of exercise often makes it hard to get a clear measurement using the manual method. This heart rate monitor is especially useful when recording heart rate changes over short time periods. At times heart rate monitors require a little body sweat between the chest strap and the skin for best conduction of the signal. In such cases, care should be taken that there is a good connection between the chest strap and the chest, and some water or other fluid can be added to enhance the conductivity too.

Source:www.chicagonow.com

Let us understand what is a normal heart rate? Well, a resting heart rate anywhere in the range of 60 - 90 is counted in the normal range. It fluctuates a lot depending on factors like activity level and stress level. Nevertheless if beat is consistently above 90, it needs medical attention. This condition of high heart rate is termed as tachycardia (increased heart rate). It has been observed that in many athletes the pulse rate is in the range of 40 - 60 depending upon their fitness level. However, a lower pulse rate is considered to be good. But if the heart rate is too low, it is termed as bradycardia and can be a dangerous situation combined together with low blood pressure. A person would feel weakness, loss of energy and fainting. It warrants for medical attention.

There can be situation when the pattern of beats are irregular (i. e. a beat is missed) on a consistent basis, such cases necessitate medical attention. There are many factors that influence heart rate like emotions, climatic temperatures, posture (sitting, standing, lying down), and body size (if the person is overweight for size, the heart will have to work harder to supply energy to your body). It is always good to experience a decrease in resting heart rate as one of the benefits of increased fitness due to exercise. This is because heart is a muscle and will respond just like any skeletal muscle in that it will become stronger through conditioning. If the heart muscles are stronger, then heart rate will decrease. In fact, heart will be putting out less effort to pump the same amount of blood.

What should be your heart rate? Are you not curious to know?

Take 220 and subtract your age. For example, if you are 36 years old, subtract 36 from 220 (220 - 36= 184). This means that your maximum physiological limit as to how fast your heart should beat is 184 beats per minute. Now see what should be yours.

Pulse rate

Your pulse can be felt at the wrist, neck, groin or top of the foot - areas where the artery is close to the skin. Most commonly, people measure their pulse in their wrist. This is called the radial pulse. How to measure your Pulse?

The first time that you try to take your pulse it may be a little difficult proposition. Place the index and middle fingers of your right hand on the thumb side of your left wrist until you feel your pulse throbbing under your fingers. Using the second hand on your watch starting the first beat at zero, count how many times your pulse beats in fifteen seconds.

Source: k0699955 www.fotosearch.com

Haemoglobin estimation

Haemoglobin is a protein used by red blood cells to distribute oxygen further to other tissues and cells in the body. It constitutes of heme, which comprises iron atoms plus the red pigment, porphyrin, (responsible for giving the blood its red colour) and globin a chain of amino acids. Haemoglobin, which is a complex protein-iron compound in the blood has an important function to carry oxygen to the cells from the lungs and carbon dioxide away from the cells to the lungs. Each erythrocyte contains about 200 to 300 molecules of hemoglobin, and then every molecule of hemoglobin consist of four groups of heme, and each group of heme has potential carry one molecule of oxygen. Hemoglobin molecule comprises four globin polypeptide chains composed of amino acids, with each polypeptide chain composed of 141 to 146 amino acids. The absence, replacement, or addition of only one amino acid alters the characteristics of the hemoglobin. Different kinds of hemoglobin are recognized by their specific arrangement of polypeptide chains. Mostly alpha and beta chains are found with gamma and delta being found less often. When there is an atmosphere of high oxygen concentration, such as in the lungs, hemoglobin has the characteristics to the bind with oxygen to form oxyhemoglobin and in an atmosphere of low oxygen concentration, such as in the peripheral tissues of the body, oxygen is substituted by carbondioxide to form carboxyhemoglobin. Hemoglobin releases the carboxyhemoglobin in the lungs for excretion and picks up more oxygen for transport to the cells. The normal concentrations of hemoglobin in the blood are 12 to 16 g/dL (grams per deciliter) in women and 13.5 to 18 g/dL in men.

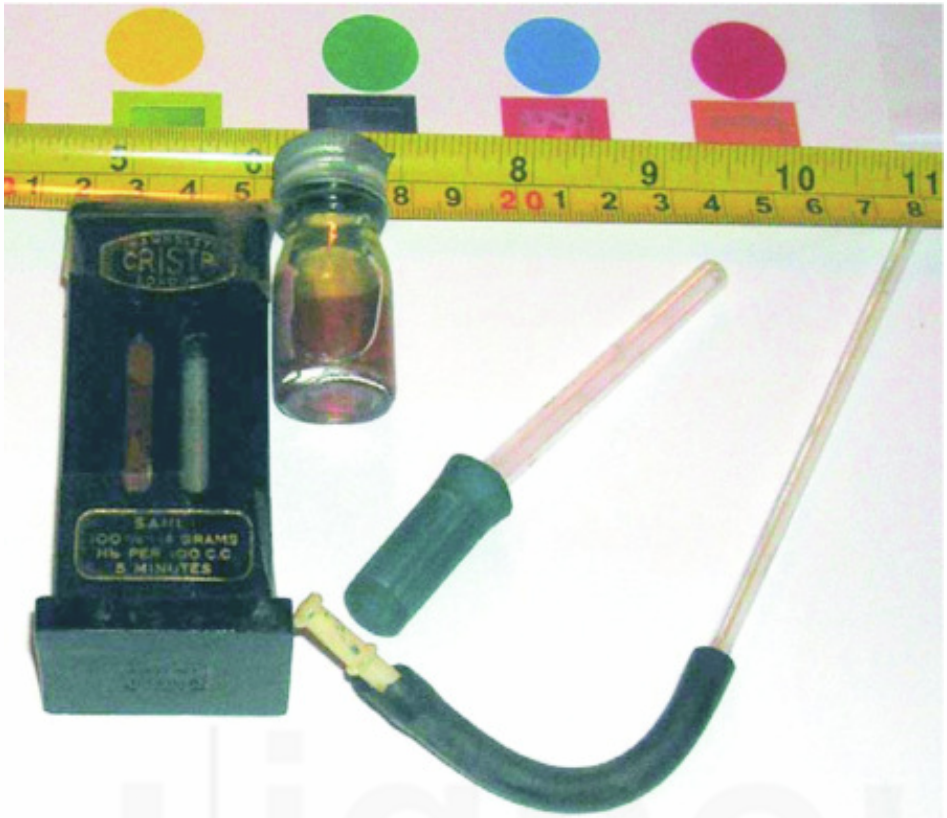
Hemoglobin estimation

A determination of the hemoglobin content of the blood is called Hemoglobin estimation. The test measures the amount of this substance in a specific volume of blood. It also indicates the amount of intracellular iron. Being an important indicator of anemia, hemoglobin estimation is also used in blood transfusions.

Methods of estimation

One of the basic techniques for estimating hemoglobin calorimetrically, is with a haemometer.

The Sahli haemometer method utilises the conversion of haemoglobin into acid haematin which has a brown colour in solution. The principle of the instrument is that Haemoglobin present in a sample of blood is changed into acid hematin by adding N/l0 HCl to the blood and its haemoglobin content is ascertained by matching the solution against non fading glass having a standard colour. The intensity of the colour is associated to the quantity of haemoglobin in the blood sample. The purpose of adding water is to dilute the brown solution until it matches that of a standard. The more haemoglobin, the more water required to arrive at the matching colour. Haemoglobin values are recorded at the meniscus of the brown solution.



Source:www.health.adelaide.edu

Sahli's Haemoglobinometer consists of:

- Comparator box possess
- Special diluting tube
- Haemoglobin pipette
- Glass stirrer
- A bottle containing Nil OHCL

Standards for estimation

Normal range Varies with altitude.

Male - 8.1 to 11.2 mmol/L (13 to 18 gm/dL)

Female - 7.4 to 9.9 mmol/L (12 to 16 gm/dL)

Child - 7.1 to 8.4 mmol/L (11.5 to 13.5 gm/dL)

Newborns - 10.5 to 13.7 mmol/L (17 to 22 gm/dl)

PRACTICE 1

Record the blood pressure of eight subjects.

Introduction

Blood pressure can be defined as the pressure exerted by blood on the arterial wall when blood enters the aorta already filled with blood. As more and more blood enters the aorta, the blood flow exerts pressure on the elastic arterial wall. This pressure is called the blood pressure. The systolic pressure is defined as the maximum pressure in an artery at the moment when the heart is beating and pumping blood through the body. The diastolic pressure is considered to be the lowest pressure in an artery in the moments between beats when the heart is resting. Both the systolic and diastolic pressure measurements hold significance clinically.

Instruments used

Sphygmomanometer, stethoscope

Procedure and Instructions

To start with deflate the bladder of the cuff. Ask the subject to sit in a relaxed position on a chair with the arms supported comfortably at the level of fourth intercostal space and facing forward. Wrap the cuff around the upper arm to fit it snugly, but not too tightly about an inch above the elbow at chest level using the Velcro. Hold the bulb/pump with your palm in such a manner that your fingers can easily reach the valve at the top to open/close the outlet to the air bladder wrapped around the person's arm. A tube leads out of the cuff to a rubber bulb and another one from cuff to the vertical glass column which has stored mercury in it. The mercury is housed within a sealed system in such a manner that only air travels in the rubber tubing and the cuff. This mercury column is very important as this is the place where the blood pressure is recorded.

Now place chest piece of the stethoscope lightly over the brachial artery above the crease of the elbow of your subject just under the edge of the cuff. The stethoscope should ideally be placed lightly over the brachial artery, since the use of excessive pressure can increase turbulence and delay the disappearance of sound. Use your right hand and hold it firmly there and the ear piece into your ears. Pump in the air through the bulb by squeezing and inflate the cuff by so that there is increased pressure and the subject feels tightening on the upper arm. Slowly open the valve on the air pump slightly, now this comes really with practice as it is neither recommended to let the air out suddenly nor too slowly as it difficult for fingers to maneuver. Be very careful while listening to the pulse when you let out the air slowly. The systolic pressure is measured when you first hear the pulse. Now as the needle on the pressure gauge starts falling you can hear a slight "blrrpp" or a something that sounds like "prrpshh.". Note down the reading when you hear it for the first time. This is systolic blood pressure. This sound continues and becomes louder with increasing intensity. Slowly this sound would become more distant and finally disappear. The reading, after which the sound of the pulse disappears, is called as diastolic blood pressure. Always remember that the blood pressure is measured in terms of millimeters of mercury (mmHg). After you have recorded the blood pressure open the valve so as to completely remove the remaining air from the bulb. It takes practice to take the

blood pressure accurately, you must get accustomed to the sound of pulse appearing and disappearing.

Precautions

Prior to initiating the practical explain to your subject the procedure and objective behind taking the blood pressure.

Check if sphygmomanometer is in functional condition.

The subject should be in a relaxed position throughout the whole process.

Blood pressure should not be taken if the subject has eaten at least half an hour prior to being measured.

Do not take blood pressure immediately after the subject has performed any physical activity.

Practice 1

Subjects	**Systolic blood pressure (mmHg)**	**Diastolic blood pressure (mmHg)**
1		
2		
3		
4		
5		
6		
7		
8		

PRACTICE 2

Record the heart rate and pulse rate of eight subjects.

Heart Rate

Heart rate is the number of heartbeats per unit of time, conventionally expressed as *beats per minute* (bpm). Variation in heart rate has been observed depending upon the body's need to absorb oxygen and excrete carbondioxide changes, like during exercise or sleep. Heart rate gives vital information on diagnosis and tracking of medical conditions. Apart from medical concerns it is used by athletes, in monitoring their heart rate to gain maximum efficiency from their training.

Instruments used

Stethoscope and stop watch.

Procedure and Instructions

Ask the subject to sit in a relaxed position on a chair. Place the chest piece of the stethoscope on the left side of the chest of the subject. It should be just below the nipple or wherever the heartbeat is strongly felt. Count the beats for one minute using a stop watch and the note down the reading.

Precautions

- The subject should be made comfortable and seated in a relaxed sitting position.
- The subject should not have exerted like exercise or brisk walking before the measurement is taken.
- The measurement should not be taken at least half an hour after the meals.

Pulse Rate

Pulse rate is the frequency of pressure waves (waves per minute) transmit along the peripheral arteries such as carotid, brachial or radial arteries. The left ventricle pushes blood into the already blood filled aorta whose walls stretches with each contraction, to facilitate the flow of the blood to different parts of the body. The expansion of arteries starts at the root of aorta and proceeds as a wave along the whole arterial system. The wave of expansion is measured as pulse rate.

Instrument used

Stop watch.

Procedure and Instructions

Ask the subject to sit in a relaxed sitting position. Turn the palm side of your subject facing up. Now, place your index and middle fingers of your opposite hand on your wrist, approximately 1 inch below the base of your hand, that is towards the thumb side of the subject's right hand (radial artery) and feel the pulse point where your three fingers are placed. Press your fingers down in the grove between your middle tendons and your outside bone. You should feel a throbbing - the pulse. Record the number of pulse by counting it for a minute using stop watch.

Precautions

The subject should be sitting in a relaxed sitting position during the measurement.

The subject should not have exercised or eaten half an hour prior to the measurement.

Practice 2

Subjects	Heart rate (bpm)	Pulse rate (ppm)
1		
2		
3		
4		
5		
6		
7		
8		

Suggested Reading

The list is given at the end of unit 4.

PRACTICE 3

Estimate hemoglobin for eight subjects.

Hemoglobin Estimation

Hemoglobin estimation is a determination of the hemoglobin content of the blood. The RBC protein hemoglobin is incharge for oxygen transport. It is perhaps the most precise way of measuring the oxygen-carrying capacity of the blood is to determine its hemoglobin content. Oxygen, which unites reversibly with the heme (iron-containing portion) of the hemoglobin molecule, is singled out by the blood cells in the lungs and delivered in the tissues. Consequently the more hemoglobin molecules the RBCs contain, the more oxygen they will be able to transport. The standard normal blood contains 12 to 16 g hemoglobin per 100 mL blood. Hemoglobin content in men is (l4 to 18 g) whereas in women it is 12 to 16 g. There are number of techniques developed to estimate the hemoglobin content of blood, ranging from the old Sahli method to expensive colourimeter methods, which are precisely calibrated and yield highly accurate results.

Instrument used

Sahli's haemoglobinometer (haemometer), distilled water, rectified spirit, cotton, lancet.

Procedure

Take 5 drops of 0.1 N HCI (Hydrochloric acid) up to the lowest mark in the diluting tube. Put the diluting tube in the space provided in the box. Rectified spirit is used to sterilize the fingertip. Prick the finger to get moderately large drop of blood. Use the pipette to suck the blood up to the 20 mm^3 mark without any air bubble. Cotton is used to wipe off any blood sticking to the tip and sides of the pipette. Transfer the blood immediately into the acid present in the diluting tube. Rinse the pipette two or three times with the acid and transfer into the diluting tube. For haemoglobin to convert to acid haematin mix and keep it undisturbed for 10 minutes. Then dilute the contents by adding distilled water drop by drop and take care to mix the contents after each drop with the stirrer, till the colour matches with the colour of the standard. Record the reading both in gram scale and percentage scale by noting the lower meniscus. Record the hemoglobin as gm/100 mL

Precautions

There should not be any air bubble or blood clot in the column of the pipette.

Graduations on the diluting tube should not interfere with colour matching.

The glass rod should be lifted up before colour matching and reading.

Wipe off the excess blood sticking to the sides and tip of the pipette.

Transfer the contents without delay into the diluting tube and record the time.

Take the reading without any delay because on keeping the colour will deepen.

Practice 3

Sl. No.	Subject/Sex/Age	Hb (gm/dL)
1		
2		
3		
4		
5		
6		
7		

UNIT 4 SEROLOGY AND DERMATOGLYPHICS

ABO BLOOD GROUP

Introduction

Human blood holds an extremely important position in our body system. Blood groups are immunological characters, determined by the presence of an antigen on the red blood cell, which are strongly inherited, hence come under the classificatory categories, which are inherited characters. Blood groups differ between individuals in a population. Population also differs in the frequency of different blood group. These differences in the frequency of blood group are characteristics of the population and thus are anthropologically valuable. Fifteen different blood group systems are known (such as ABO, MN, Rh, Lutheran, Kell, Duffy, Kidd, Lewis, Diego, etc) each controlled by a separate locus, and at each locus multiple alleles are known to be present.

What is the basis of classifying blood in different blood groups?

It is the antigen – antibody reaction. Antigens are proteins which excite the production of antibodies and antibodies are substances in the serum or plasma which are very specific to an antigen reaction.

What does Blood grouping imply?

It is process of testing the unknown red cells with known antiserum.

Now how do you identify the antigens?

Different antigens on the red cells are specific to the antibodies (proteins in serum) which when react with the antigens cause agglutination of the red blood cells.

What do you understand by agglutination?

Agglutination refers to clumping, clustering or bundling together of red blood cells.

ABO blood group has naturally occurring antibodies in their serums; while in others like MN and Rh, it can be produced through immunization. As mentioned earlier the basic principle of blood grouping is an antigen-antibody reaction. A particular antigen reacts only with its specific antibody and not with others. The reaction is an observable phenomenon in the form of agglutination.

ABO BLOOD GROUP SYSTEM

As you already know A, B, AB and O are commonly known blood groups. How do we differentiate between them and create an identity for them? The presence or absence of blood group antigens A and B on the red cells forms the basis of classification of ABO blood group. If antigen –A , is present on the red blood cells then there are anti-B antibodies in the serum; similarly, if there is antigen – B, on the red blood cells then, anti-A antibodies are found in the serum. If, in a person both antigen A and antigen B are present on the red cells, then neither antibody in the serum is found and people who do not contain either of the antigens on the red blood cells have blood group O and thus have both the anti-

A and anti-B antibodies in their serum. This means that type A blood group indicates the presence of antigen A, while type B blood group shows the presence of antigen B. Type AB blood group, as has been mentioned earlier, has both the antigens A and B, while type O blood group has no antigens. In the ABO system, antibodies are there in the serum right from the time of birth. Individuals with Group A blood group have anti-B in their plasma, those with group B blood group have anti-A, AB individuals have neither, while O individuals have both the antibodies.

The antigen-antibody reactions hold an important criterion for determining the mode of blood transfusion. For example, all the people belonging to blood group A can take blood from A blood group people, but not from other blood groups, like B or AB blood group. In blood group O, no antigen is present on the red blood cells; therefore it can be transfused to persons with other blood groups.

ABO blood group system holds an important position as far as its applications are concerned. It enjoys wide field of application like in ethnic diversity, blood transfusion, paternity diagnosis, genetic counseling and also in forensic investigations including medico-legal angle and detection of drugs in blood. Furthermore, different blood groups show certain level of association with particular disease, such as Blood group A shows an association with cancer of the stomach.

Let us understand how blood groups are inherited. The ABO blood group system is controlled by a single locus with three alleles viz. A, B and O. They hold responsibility for the production of antigen-A, antigen –B, and neither antigen, respectively. Alleles A and B are both dominant hence are referred as co-dominant, while allele O is recessive to both. There are two subtypes of the group A, designated as A_1 and A_2 and, therefore, A is replaced by two alleles, A_1 and A_2. A_1 is dominant over A_2. It is because of $A_1$and A_2 which is two sub-types of group A, the system ABO Blood group has been designated as Blood group A_1A_2 BO. The four alleles give rise to ten genotypes and six phenotypes as given below:

Phenotypes	Genotypes
A_1	A_1A_1, A_1A_2, A_1O
A_2	A_2A_2, A_2O
B	BB, BO
A_1B	A_1B
A_2B	A_2B
O	OO

As mentioned earlier let us look at the antigen and antibodies in the ABO blood group system again

Blood group	**Antigen**	**Antibody**
A	A	anti - B
B	B	anti - A
AB	A,B	-
O	-	anti - A, anti - B

The fundamental principle behind ABO blood grouping is that, an unknown blood sample or red cells are agglutinated, when treated by anti-A serum, the cells are classified as belonging to group A; if there is reaction with anti-B serum, the cells are classified as blood group B; if there is reaction with anti - A as well as with anti-B serum, the cells are said to be belonging to group AB. When there is no reaction with either anti-A or anti-B serum, the cells are classified as group O. We can understand this from the following table:

Reaction in the ABO blood group system

Determination of A_1A_2BO Blood group using Anti- A, Anti- A_1, Anti- A_2, Anti- B, Anti- AB and Anti- H

Anti sera					Blood group
Anti A	Anti B	Anti AB	Anti A_1	Anti H	
+	-		+		A_1
+	-	-		+	A_2
-	+				B
-	-	-		+	O
+	+	+	+		A_1B
+	+	+	-	+	A_2B

ABO Grouping Technique involves the following steps:

1) Preparation of normal saline: Dissolve 8.5 to 9.0 gms of Sodium Chloride in 100 cc of distilled water, which will make 8.5 to 9.0 % of normal saline. (8.5 gms is ideal as it allows for increased concentration of salt as a result of evaporation of water). This solution is called isotonic with respect to red blood cells of the human body.

2) Blood collection and making 2% red cell suspension: Clean the finger from which the blood is to be taken with cotton swab soaked in methanol.

   Prick the finger with a new disposable lancet.

   a) Collect the blood in the micro tube which already has 24 drops of normal saline solution.

   b) Centrifuge the tube which has distilled water and a drop of blood.

   c) Take the supernatant with the pipette.

   d) Pour 24 drops of normal saline into the tube.

   e) Centrifuge it twice. There is a risk of washing away the antigen on the surface of the red blood cells, if centrifuged more than thrice.

   Did you realise how you made 2% red cell suspension?

   Each drop of blood contains half a drop of cells. Now, when you add 1 drop of blood to 24 drops normal saline solution it makes 2% cell suspension. $^1/_2$ drop in 25 drops makes it 2 drops in 100 drops i.e. 2%.

3) Mix the blood with the respective serum: Take a grooved slide in which the groove resembles the bottom of the tube, this aids in the agglutination.

a) Clean the groove with spirit and dry it.

b) Put a drop of anti-A serum in one groove and a drop of Anti-B serum in another groove.

c) Add a drop of the prepared 2% cell suspension in each groove

Take a cleaned and dried dumble-shaped glass stud and stir the mixture of blood and sera in a circular motion.

4) Determination of blood by examining the agglutination: Examine the groove for agglutination.

If there is a positive reaction or agglutination when treated with anti –A serum, it is blood group A. Similarly when treated with anti –B serum, it is blood group B (if agglutination is noticed). If the agglutination is observed when treated with anti-A and anti-B serum, it is blood group AB. If no agglutination is observed with either serum, it is blood group O.

Rh blood group

Landsteiner and Weiner deserve the credit of discovering Rh factor in 1940. How did they give the name Rh to the blood group?

They injected the blood of rhesus monkey, in a rabbit and found antibodies formed in the rabbit. These antibodies agglutinated the red blood cells of all the rhesus monkeys. This occurred because the monkey's erythrocytes bear a particular antigen designated as Rh. Human beings that produce anti-Rh antibodies are Rh^+ (Rh positive) and those who do not are Rh^-. There are very few people who are Rh^- (Rh negative). Antigen D most commonly referred to as Rh^+ blood group antigen is frequently concerned with the problems of blood transfusion and sometimes with those of pregnancy.

The blood group Rh can be analysed by two methods

Slide Test Method

Rapid Test Tube Method

Slide Test Method

a) Put a drop of anti-D serum on a warm (47 degrees Celsius) slide.

b) Add 1 drop of 40% red cell suspension in normal saline to be tested.

c) Mix the contents systematically with the applicator stick.

d) Move it back and forth for about 2 minutes.

e) Use a hand lens to check the agglutination.

Rapid Test Tube Method

a) Take a clean dry test tube and put a drop of anti-D serum.

b) Add 5% red blood cell suspension to the test tube.

c) Mix the contents in the tube thoroughly and centrifuge for 2 minutes at 1000 rpm.

d) Care should be taken so that there is no hemolysis as it can be misinterpreted as negative result.

e) Suspend the cells by gentle shaking.

f) Use hand lens to see if agglutination is present or not and accordingly record the result.

Anti - D	Blood group
+	Rh^+
–	Rh^-

PRACTICE 1

Analyse the blood sample for ABO and Rh blood group for eight subjects.

Introduction

The blood groups are identified in ABO group on the basis of presence or absence of antigen A and B on red blood cells. They are identified on the principle of agglutination reaction between the unknown blood and the sera of known antibody. Suppose the unknown red blood cells get agglutinated by anti-A sera then the blood group is A, if the unknown red blood cells get agglutinated by anti-B sera then the blood group is B, if it reacts with both the sera, then the blood group is AB and if no agglutination occurs with any sera, it is blood group O.

When the unknown blood is treated with anti-D and agglutination takes place then the blood is Rh^+ (Rh positive) and if no agglutination takes place, then the blood is Rh^- (Rh negative).

Material

The following apparatus and reagents are required for blood collection and analysis of ABO and Rh blood group:

Apparatus

1) Beakers
2) Centrifuge
3) Cotton
4) Droppers
5) Eppendrof tubes
6) Forceps
7) Funnel
8) Glass marking pencil
9) Lancet
10) Leucoplast
11) Measuring cylinder
12) Ordinary test tubes
13) Porcelain tiles
14) Petri dishes
15) Scissors
16) Slides
17) Stirrer
18) Test tube stand

Reagents

1) Anti- A
2) Anti- B
3) Anti- AB
4) Anti- D
5) Anti- H
6) Distilled water
7) EDTA
8) Methanol
9) Normal saline solution (0.9%)

Method

Blood sample collection

Collect the blood samples in the eppendrof tubes which contain EDTA. The blood samples are transferred to the ordinary test tube with saline water for testing ABO blood groups and Rh factor, then the blood samples from the eppendrof are transferred to the slide for analysis.

a) Cleanse the subjects' left ring finger with cotton swab soaked in methanol.
b) Prick the finger with sterilized disposable lancet and collect few drops of blood in the eppendrof. The ordinary test tube for ABO blood group contains 3-4 ml of normal saline solution.
c) Now analyse the blood

There are two methods for blood analysis

Slide Method

a) 10% suspension of cells in physiological saline is prepared.
b) Place a drop of anti-A on one side or one cavity of the tile
c) Place a drop of anti-B on the other side
d) To each half of the slides add a drop of 10% red cell suspension.
e) Mix the cells and serum with clean corner of the slide and then mix it to smooth suspension
f) Shake the slide back and forth and gently rock.

Allow it to stand for 2-3 minutes shaking it gently occasionally to ensure thorough mixing.

Cell Suspension Method

a) Centrifuge the blood samples with normal saline solution for about 2-3 minutes at 2000 rpm.
b) Discard the supernatant through the dropper.
c) Add normal saline to the RBC button
d) Shake it thoroughly so that the cells are suspended in the saline
e) Centrifuge and repeat the step

f) Prepare 5% cell suspension i.e., 18 drops of saline and one drop of RBC for subsequent analysis.

g) Pour RBC suspension of the subject with the help of a dropper, in the different grooves of the porcelain tile.

h) Put a drop of antiserum in each drove

i) Allow it to coagulate for the analysis.

Analysis

The analysis of the blood group is based on agglutination reaction between antisera and antigen present in the body.

a) If the red blood cells carry the corresponding antigen to the known antibody, note that agglutination would take place.

b) No agglutination indicates the absence of particular antigen

See the table below to understand it better

Unknown red cell samples

	1	2	3	4
Anti- A	+	-	+	-
Anti- B	-	+	+	-
Blood group	A	B	AB	O

Here + denotes complete agglutination and – represent no reaction i.e. no agglutination.

Rh factor is based on agglutination between the antigen on RBC and anti- D.

A) Transfer the blood sample on the slide using a micro dropper;

B) Pour a drop of anti- D using a micro dropper on the blood sample;

C) Allow it to agglutinate for analysis;

D) If agglutination of the cells is noticed, it indicates blood group is Rh^+ (Rh positive); and

E) If no agglutination of the cells takes place, it indicates the blood group is Rh (Rh negative).

Precautions

a) Use cotton swab with methanol to clean the finger before the prick.

b) Dispose off lancet after single use.

c) Use separate droppers for separate suspensions.

d) Collect the blood properly in the eppendrof tube without any loss.

e) After you collect the blood in eppendrof gently mix with EDTA properly.

f) Put the blood samples thus collected in the ice box as soon as possible.

g) Test the blood within 24 hours of collection.

h) Clean all the glassware to be used.

i) Pour few drops of EDTA in the Eppendrof tubes.

j) Take equal quantity of serum and cell suspension for I deal results.

Practice 1

Subject	Anti A	Anti B	Anti D	Blood group
1				
2				
3				
4				
5				
6				
7				
8				

DERMATOGLYPHICS

Cummins and Midlo (1962) coined the term Dermatoglyphics which is derived from two Greek words 'Dermato' which means skin and 'glyphics' meaning carving. Basically, it is the science of epidermal ridge pattern on human fingers, palms, toes and soles. Print of the palm is termed as palmar print and that of feet is referred to as plantar print. If you want to study extensively the skin pattern of any area, it is best studied in detail when the print of whichever area you want is taken following standard method. Before we learn the methods to take print, let us get familiar with certain terms that will help in understanding the objective better.

Ridges: The ridge patterns have an identity of their own. Did you notice that the palmar and plantar surfaces and fingers in man lack hair and sebaceous glands with plenty of sweat glands. That is, the ridged skin with sweat is structural specialisation among human beings. The ridges on our skin or epidermal ridges form a regular pattern on the phalanges of the digits, palms and soles. Every individual possesses distinct features of ridges and their pattern in fingers, palms and soles and remain stable all through life. From the anthropological perspective, it holds an important position as they are one of the anthropological characters that are relatively stable for a population. Not only does it provide invaluable information in forensic anthropology, but an association with genetic conditions and chromosomal aberration has also been observed. The evolutionary relationship with the hand and foot prints of primates with humans holds important comparative information too.

Source: www.barcode.ro

Ridge Configurations: The epidermal ridges or the ridges on the skin are not just random. They form a definite local pattern on the terminal segments or phalanges of the digits and also on the palm and sole. This holds an extremely important position in personal identification, inheritance, racial variation and other biological aspects of dermatoglyphics as mentioned earlier due to immense variation of the configuration. The configuration present on distal phalanges of finger and toes, depending upon their construction are termed as arches, loops and whorls by Galton (1892). Except for plain arches all other configurations appear to be composed of abruptly curved ridges. Actually, plain arches have

parallel ridges and is a special form of open field too. The middle and proximal segments of the digits seldom exhibit true patterns because of configuration which could be open field or erratic arrangement of ridges called vestiges.

Triradius: Triradius as the name indicates is the meeting point of three systems of parallel ridge systems which are called radiants; hence it holds a distinct landmark in parallel ridge system. There are four digital triradii, positioned at the base of the digits II, III, IV and V. When referred from radio-ulnar order it is called as a, b, c and d. The two distal radiants encompass the digital area of each distal triradius. Whereas, the proximal radiant heads towards the interior of the palm, and when fully traced this radiant shapes the palmar main line. Subsequently, the genesis of the four main lines are the four digital triradii point which are assigned A, B, C and D. The margin between the thenar and hypothenar eminences, is the axial triradii also called as't'-triradius. Sometimes, the axial triradius is positioned more toward the centre of the palm. There may be more than one of this triradius, and in rare cases, there may be none. The distal radiant of this triradius, when fully traced, is its main line, designated as 'T'.

Source: www.multiperspectivepalmreading.com

Core: It constitutes the main focus of the pattern as, when the ridges of the pattern diffuse around this centre they take the shape of an island, a short straight ridge, a hook shaped ridge, a circle etc. Sometimes two or more short straight ridges form the core of a pattern.

Source: www.webopedia.com

Finger Topography

Did you realise that there is a pattern on the ball of the fingers? Notice that these ridges in the larger area run parallel to each other, whereas in smaller area they bend to form discontinuity. These are called patterns. As mentioned earlier Galton differentiated the prints or configuration on fingers as whorl, loop and arch. But then Henry proposed composites to be included in these three as the fourth one. Often whorls and composites are combined and Galton's three fold classification is ensued. Let us briefly understand the patterns:

Fingertip patterns representing an arch (A), loop (B), and whorl (C). Adapted from Holt (*Holt SB. Quantitative genetics of finger-print patterns.* Br Med Bull 1961*;*17*:*247*–50)*

Arches: These are most uncomplicated of all the patterns and are commonly referred to as patternless configurations. There are two types of arches:

Plain arch (A): There is no triradius which is connected with the ridges, and ridges flow from one margin to the other slightly bowing, distally characterised by three arch curves.

Source: www.students.stedwards.edu

Tented Arch (TA): It appears to have triradius on which the ridge overtops moving from one margin to another in the form of a tent.

Source: www.policensw.com

Loops: In this the ridges of the loop form head of the loop by curving around only one extremity of the pattern, whereas on the opposite extremity it is said to be open as ridges flow to the margin of the digit. Loops are known to have only one triradius and the extremity in which this triradius lies is a close area. Loops turn at an angle of 180 degrees and are generally associated with one triradius.

Ulnar loop (UL) as the name suggests opens to the ulnar side and then the triradius is on the radial side. Subsequent loops which are on the toes and soles are called **Fibular loops (FL)** which naturally opens to the fibular side and in this case triradius is on tibial side.

Radial loop (RL) similarly opens to the radial side and in this case triradius is on the ulnar side. In this case the corresponding loops on toes and soles are called **Tibial loop (TL)** which as the name indicates open to the tibial side and triradius is on fibular side.

Distal loops open to the distal side. A loop on palm or sole generally opens in the direction of finger or toes i.e., distal side.

Proximal loops are the loops that open on the wrist side as on the thenar area of the palm.

Whorls (W) are the patterns with two triradii with ridges forming circuit around the core.

True Whorls are the ones which have single core and at times double core too. In this the ridges go round 360 degrees.

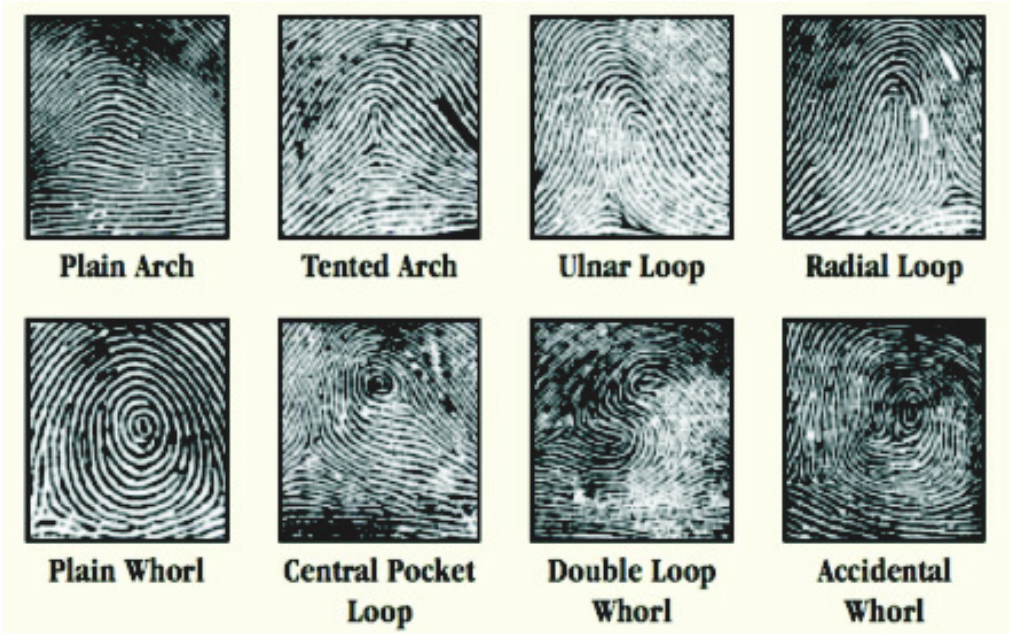
Double loop type of Whorl:

Central Pocket Loop (CPL) is a whorl, distinguished, as it bears a small loop within a loop.

Twin Loop (TL) as the name suggests is a type of whorl where two loops open to opposite direction.

Lateral Pocket Loop (LPL) is a whorl where in two interlocked loops open to the same margin.

Superwhorl (SW) is a condition when the pattern has three loops and three triradius.



Source: www.viewzone.com

Twin Loop

Source:www.fotolibra.com

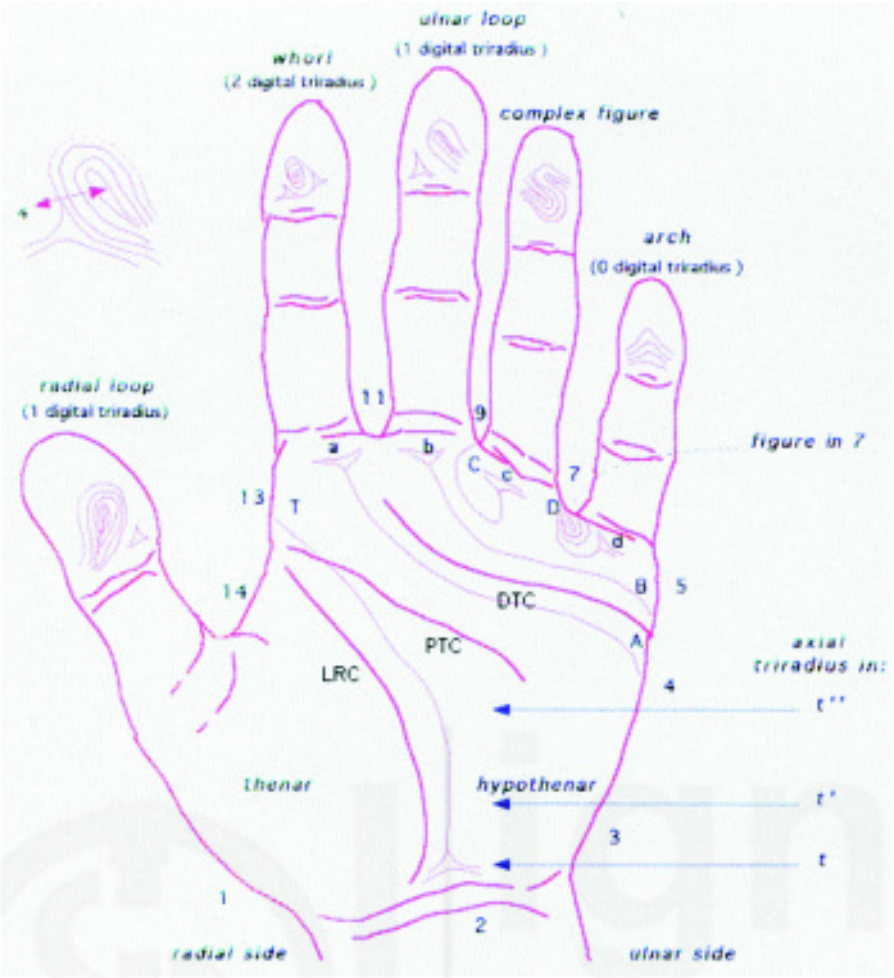
Palmar Topography

Look at your palms carefully. The proximal area of the palm is bound by a bracelet crease, very much like the name, and on the other side are the metacarpo-phalangeal creases. There are about six elevations around the hollow of the palm, varying in prominence. Four of these are interdigital pads, lying in the proximal to the interdigital intervals and are numbered accordingly as I, II, III and IV. The remaining two out of six are the thenar eminence occupying a large area of the proximodigital quadrant at the base of the thumb. These are bound by the radial longitudinal crease which is popularly called as the life line. Opposite to this, the hypothenar eminence is distinct; lying is a more elongated elevation, in the ulnar portion of the palm. Notice the shape of the palm, it runs in four anatomical directions proximal, distal, radial and ulnar.

Numbering the Palmar Area and the Main Lines

The margin of the palmar area is divided into 14 points and intervals. The number sequence begins with the proximal part of the thenar eminence. On the radial side of the axial triradius and at the base of the thumb, number 1 is given; this area continues around the proximal, ulnar, distal and radial borders of the palm. Number 2 position is allotted to axial triradius which is a point. The approximate midpoint of the ulnar margin is designated as 4; the digital areas are represented by 6,8,10 and 12. The interval between the points 4 and 6 is numbered 5, which is further divided into 5' which is the proximal half, and 5'' which is the distal half. Here the rule is that, each of the marginal areas of the palm are numbered following the principle that points are given even numbers, 2, 4,6, 8,10 and 12 beginning as mentioned above from the base of the palm behind the thumb (No.1), moving from ulnar to radial side, and odd numbers 1,3,5,7,9,11 and 13 are given to intermediate areas as shown in Figure.

It is the radiants of the triradius that traces the lines in the form of loops and whorls which are called as the Type line. One can identify the pattern on the basis of these lines. The longest radiant of digital triradius is the main line, hence the designation of main lines as D, C, B, A and T lines (see Figure).



Source: www.atlasgeneticsoncology.org

PRACTICE 1

Record the finger and palm prints of eight subjects

Material used: Magnifying Glass

Inking Plate (Metal or ¼" Glass) 6" wide x 14" long

Card Holder

Hardwood stand 2' length x 1' height and width

Cleaning Fluid or Cream

Paper Towels

Roller

Inking Plate Cleanser

Printer Ink/Stamp Pad Ink (heavy black paste),

Note: Printing ink or ordinary ink or infact any other coloured inks are not advised for fingerprinting work. The reason being they are too light, thin and do not dry quickly.

Finger Print Method

a) Clean the hand of the subject and dry with clean towel.

b) Smear the ink over the fingers.

c) Hold the terminal knuckle of the finger and roll it from radial to ulnar side. The thumb should be rolled from opposite side.

d) The ideal finger prints should be square in shape. The triradii should be visible in the print. One triradius for loop, two triradius for whorl and three triradius on a super whorl.

Palmar Print Method

a) Hold the wrist of the subject and place the hand on the inked slab uniformly.

b) Lift it up slowly from the ulnar end of the palm.

c) Place the palm on the paper.

d) Press the interdigital areas and hollow in the centre of the palm.

e) Remove the palm from the paper slowly without any jerk pressing the centre of the palm.

f) Roll the palm on the ulnar end.

g) Take care that there is uniformity in the print including that of the hollow in the centre and ulnar end of the palm.

Practice 1

Recording the pattern from finger prints and Palmar prints of eight subjects

PALMAR DERMATOGLYPHICS

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S.No				Name		Age	Sex	Date of Printing Date of Analysis		
D	C	B	A	Axial Triradius	Hypothenar	Thenar/I	II	III	IV	MLI

FINGERBALL DERMATOGLYTPHICS

Discipline of Anthropology, IGNOU.

Name
Age
Sex
Date of Printing
Date of Analysis

Pattern Typing (RIGHT HAND)

I	II	III	IV	V

Pattern Typing (LEFT HAND)

I	II	III	IV	V

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