

APPENDICULAR SKELETAL SYSTEM

The Appendicular skeletal system consists of the bones of the arms and legs. It is important to remember that these are bony structures that can sometimes be used to find important structures. Other times they may be the sight of damage that can be tested directly. Before looking at the appendicular bones, it is vital to get a grasp to the vocabulary of the bones. Review the list from the Axial skeletal system you made as many structures will have similar names. It is also recommended that you memorize the words below.

1. Medial= going toward the midline of the body
2. lateral= going away from the midline
3. Superior (supra)= To the head area
4. Inferior (infra)= away from the head
5. Anatomical position= feet point forward, palms facing forward, face forward
6. Proximal= closer to (usually the head)
7. Distal= farther
8. Articulation= where two bones touch and can move.

Arms:

The arms can be studied by starting with the shoulder which is formed by three bones. Two of these bones are in direct contact with the axial skeletal system. The shoulder blade, called the scapula is located posterior to the thoracic cavity. The Scapula is roughly a triangle shaped bone which glides over the ribs as the shoulder moves. This triangle shape has three borders, the medial, lateral, and superior borders as well as three angles: Inferior, lateral, and superior. On the lateral angle of the scapula, is the glenoid process where the humerus will fit in. On the scapula's dorsum, is a spinous process with a fossa on both sides of it called the supraspinatus and infraspinatus fossa. On the lateral most part of the spine is a projection called the acromial process. On the scapula's ventral side, one can find the subscapular fossa.

1. On the picture, label the following:
 - a. Vertebral column
 - b. Scapula
 - i. Medial border
 - ii. Lateral border
 - iii. Superior border
 - iv. Inferior angle
 - v. Superior angle
 - vi. Lateral angle
 - vii. Spinous process
 - viii. Infraspinatus fossa
 - ix. Supraspinatus fossa
 - x. Acromion

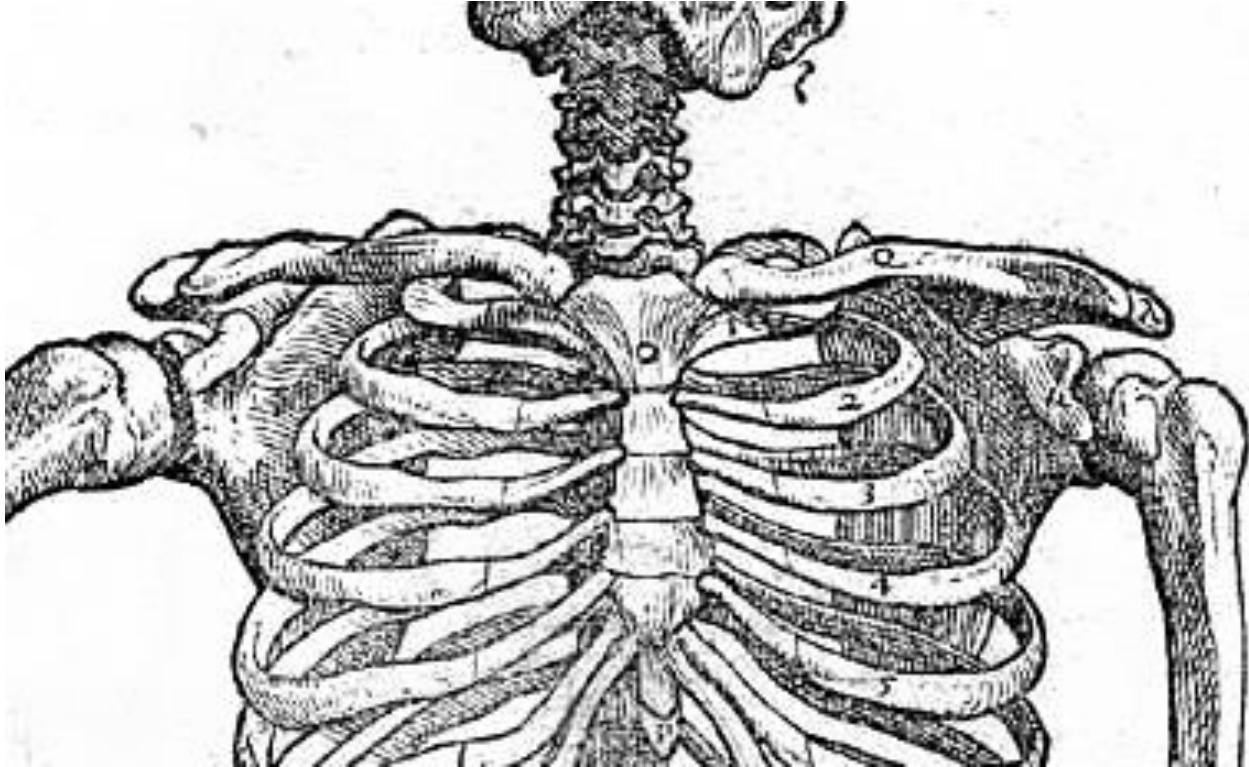


As mentioned, the scapula floats over the ribs when people move their shoulder around. If you were to feel the spine of the scapula as someone reaches upward, you would feel it rotate so that the lateral end of the spine moves superiorly while the inferior side moves lateral and inferiorly. If one follows the spine of the scapula to its lateral most end, we see a hanging projection called the Acromial end. Joining at the acromial end is the clavicle, known as the collar bone in layman's terms. On the anterior aspect of the scapula, there is a finger like projection called the coracoid process.

The clavicle is an important bone which has many peculiarities, for one, it is formed through intramembranous ossification rather than the endochondral ossification its shape would suggest. At the clavicle's medial end is the sternum so it is called the sternal end and as its lateral end connects to the acromion, it is the acromial end of the

clavicle. As the clavicle tends to stabilize the shoulder, when it fractures, many times it leads to dislocation of the shoulder.

2. On the picture label the following to make yourself a key:
- | | |
|----------------------|----------------------|
| a. Sternum | c. Scapula |
| i. Manubrium | i. Acromion |
| ii. Body | ii. Coracoid process |
| iii. Xyphoid process | iii. Glenoid process |
| b. Clavicle | iv. Neck of scapula |
| i. Acromial ends | |
| ii. Sternal end | |



There are joints in the body where two or more bones come together, these are called joints. In the skull, as these joints are fused so we called them sutures. In the appendicular skeletal system, the joints of the human body are many times named after the bones they are composed of. For instance, between the sternum and clavicle we have the sternoclavicular joint. Between the Acromial process of the scapula and the acromial end of the clavicle we have the Acromioclavicular joint.

Look at the shoulder joint and pay close attention to the location where the humerus joins the scapula. This joint is called the Glenohumeral which is a ball and socket joint allowing for a great amount of movement. This joint has traded off stability for mobility. In fact, you will note that the bones would not hold together well if not for muscles.

3. On the image above label the following joints:
- Acromioclavicular joint
 - Sternoclavicular joint
 - glenohumeral joint

On the anterior aspect of the humerus, you find the head at the proximal end followed by two large bumps just under it. These are the greater and lesser tuberosities and the indentation between them is the intertubercle fossa. Between the tubercles and the head, we find a neck area called the anatomical neck. The area below the tubercles is

the area called the surgical neck. Follow the humerus to the midshaft where there is a bony projection on the lateral side. This is called the deltoid tuberosity. On the distal end there are two grooves, one for the radius and other for the ulna. These two grooves are called the Radial Fossa for the radius and the Coronoid fossa for the process of the ulna which fits in there. Distal to the Radial fossa is a head-like projection called the Capitulum (Capit means head) and medial to the capitulum is the Trochlea, a spool-like projection.

On the posterior side, there is a large groove where a portion of the ulna enters. That is called the Olecranon Fossa after the process found on the Ulna. Then, on both sides of the Olecranon Fossa, you will find two wing-like projections called epicondyles. One points to the body called the medial epicondyle the other, which points laterally is the lateral epicondyle.

4. Label the image which is the anterior aspect of the Humerus then label the following.
 - a. Greater tubercle
 - b. Lesser tubercle
 - c. Head
 - d. Anatomical Neck
 - e. Surgical neck
 - f. Intertubercle groove:
 - g. Radial fossa
 - h. Coronoid fossa
 - i. Trochlea
 - j. Capitulum
 - k. Medial/ lateral epicondyle

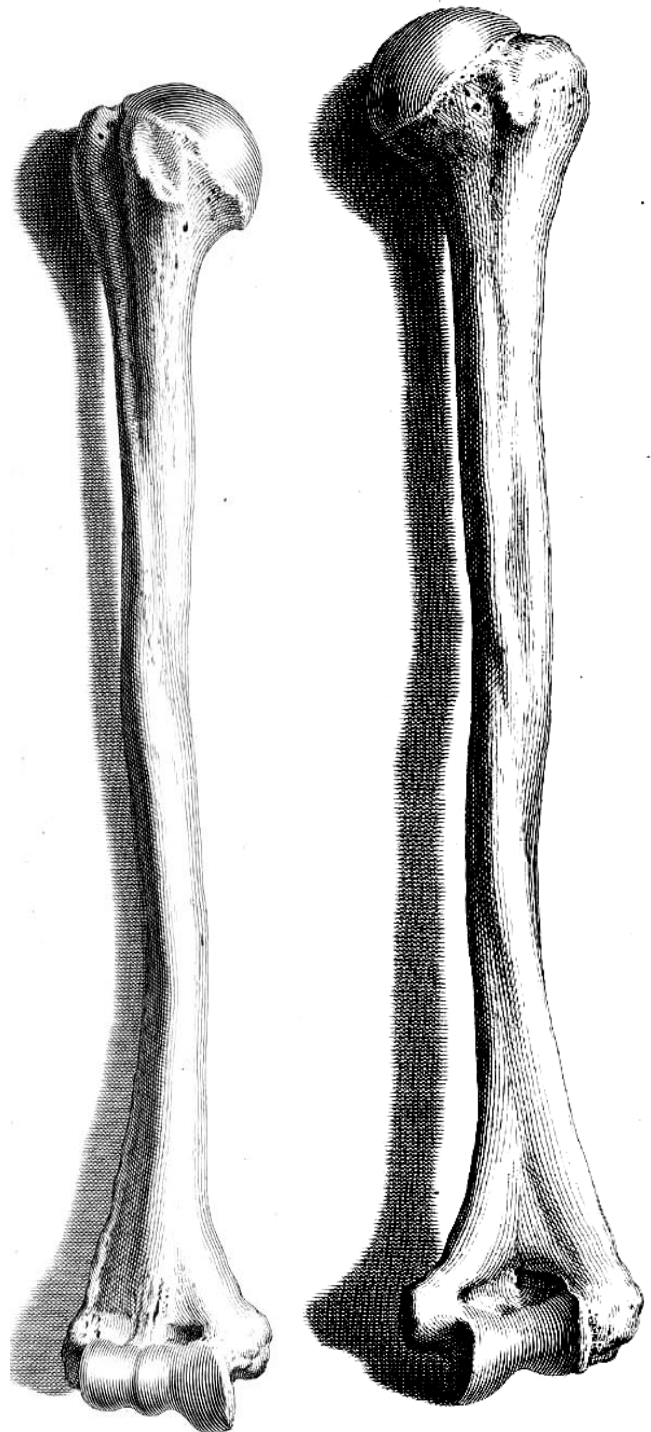
5. Label the posterior aspect of the humerus and label the following:
 - a. Head
 - b. Neck (surgical and anatomical)
 - c. Deltoid tuberosity
 - d. Olecranon fossa
 - e. Trochlea

Distal to the Humerus, on the Medial side of the forearm (when looking at the body in anatomical position) is the Ulna. Looking at the ulna with the humerus in place, note how it opens and closes like a hinge. On the posterior portion of it you have a large process that interacts with the posterior groove of the humerus. Feel it on your partner and notice how it moves as you flex and extend your arm.

On the posterior side of the ulna, at the point which forms the tip of your elbow is the Olecranon process of the ulnar bone. If you have a skeleton to look at you will see that it fits into the cavity called the Olecranon fossa.

When looking at the body in anatomical position, you can palpate the Ulna from its Olecranon process all the way down to its head located near the wrist by the smallest finger. The large lump palpated is the head of the Ulna which is attached to a pin-like projection called the styloid process of the Ulna.

Looking at the anterior aspect of the ulna, where it articulates with the humerus, we see a notch called the ulnar notch and an extension of bone which will fit into the coronoid fossa. The projection is called the



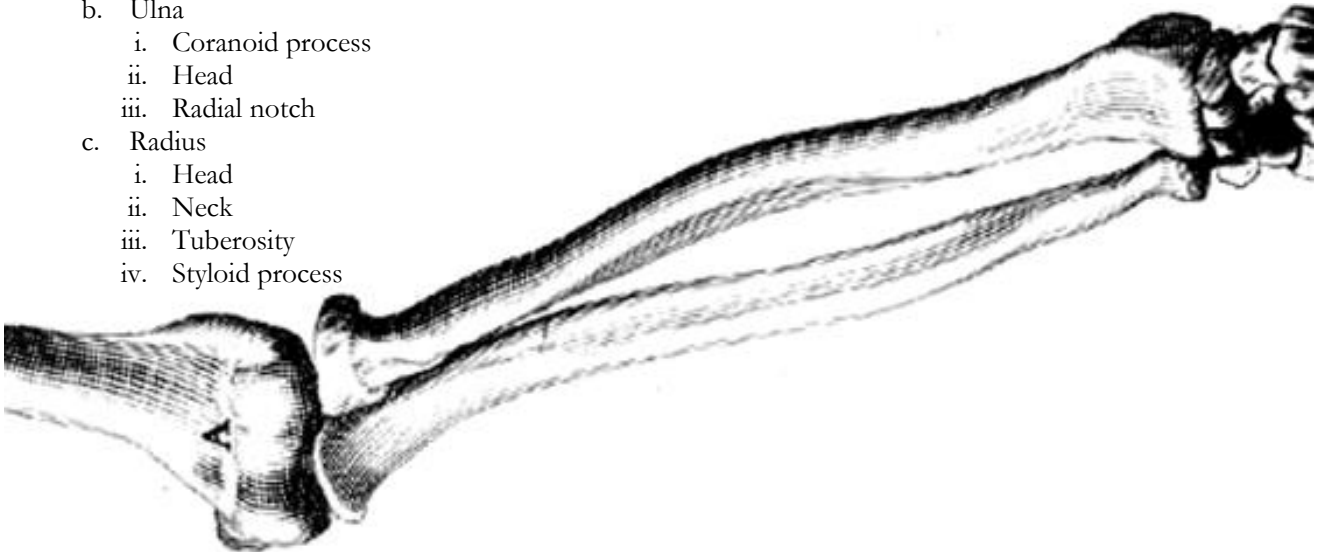
Coronoid process of the ulna. Lateral to the Ulna, near the coronoid process, we see a deep rounded groove called the Radial notch of the Ulna.

6. What is the name of the process which fits into the Olecranon fossa?
7. What is the process which fits into the coronoid fossa?
8. What are the two bones that articulate with the humerus on the distal end?

Lateral to the Ulna and distal to the humerus we find the Radius with its round, wheel-like head inside the Radial notch of the Ulna. There is a large lump of bone distal to the head of the radius called the Radial Tuberosity and between the head and radial tuberosity we have the neck of the radius.

On the radius, at the proximal end, it articulates with the ulna on the proximal end then look at how it articulates at its distal end. On the distal end of the radius, you find a notch for the Ulna called the ulnar notch of the radius and on the lateral side, one can find a styloid process of the radius.

9. What is the shape of the radius at the proximal end (remember its name)?
10. What part of the radius would fit into the radial fossa of the humerus?
11. On the picture, label the following:
 - a. Humerus
 - b. Ulna
 - i. Coronoid process
 - ii. Head
 - iii. Radial notch
 - c. Radius
 - i. Head
 - ii. Neck
 - iii. Tuberosity
 - iv. Styloid process



12. When you get to the wrist notice how both the ulna, and radius look, what area and bone allow the forearm to rotate?
13. Which bone in the forearm is closest to the thumb?

While fractured can occur anywhere, there are some structures of the arm that cause more complications. The Clavicle, for instance can fracture when passing through the birth canal which can lead to damage to major nerves of the arm. Due to its odd shape, if one falls on a shoulder it can fracture. If this fracture is unstable, it can damage the nerves and arteries just below it.

In the humerus, the medial epicondyle can fracture due to a fall or direct trauma. As a major nerve run near this it can lead to some loss of function. As the Radius forms part of what is known as the support column of the arm, a fall onto an outstretched hand can lead to what is called a Colle's fracture. This fracture has a characteristic

dinner-fork deformity due to the posterior dislocation of the fractured portion. The Ulna is more prone to fractures due to direct blows as is seen in a “Nightstick” fracture.

The wrist is made up of many bones of different shapes which are collectively called the carpal bones. They are attached to the bones of your hand known as your metacarpals. The carpal bones have different shapes; Scaphoid is a boat shaped bone closest to the radius. Medial to the Scaphoid is the Lunate (moon shaped), followed by the Triquetrum which means three cornered. Anterior to the Triquetrum is the Pisiform which means pea shaped. Moving to the next row of bones of the wrist, we find the Trapezium at the distal lateral of the carpals. Next to this going medially, we find the trapezoid. This is followed by a skull-shaped bone called the capitate and finally the square-shaped bone with a hook called the hamate.

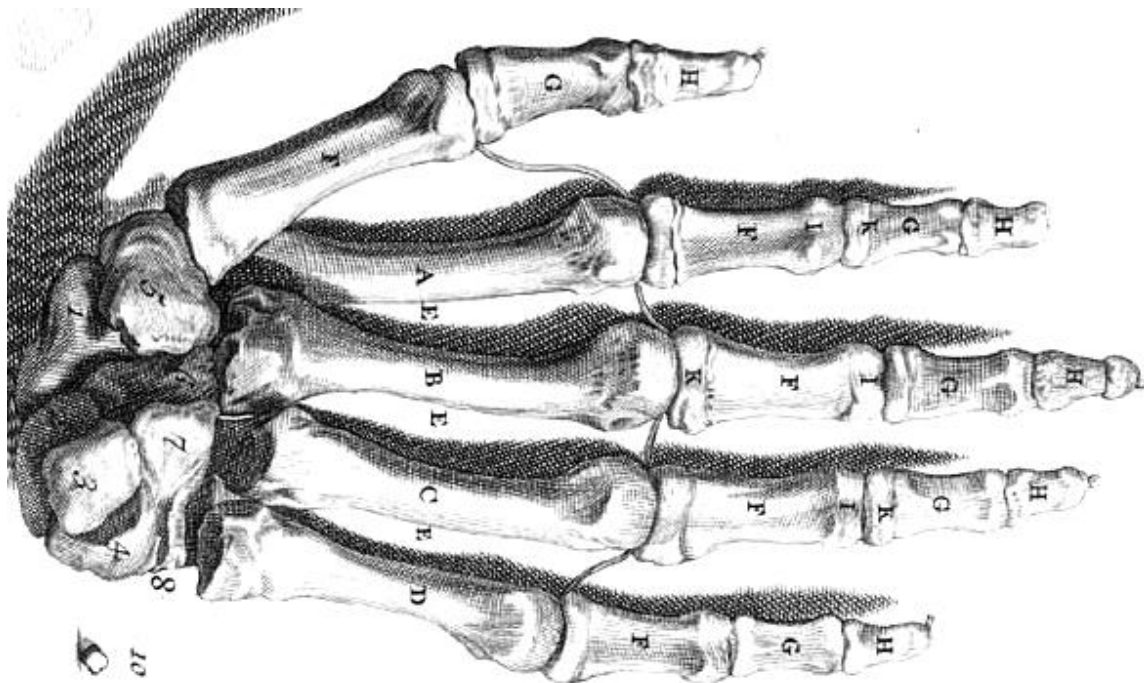
Of the Carpal bones, there are some that fracture more often than others. The most fractured carpal bone is the Scaphoid which is broken when someone falls on an outstretched hand. The main problem with a scaphoid fracture is that it does not show up on normal x-ray for about two weeks. The hook of the hamate can also be fractured by a force striking it. The hamate fracture was called a “Driver’s fracture” as it was caused by the crank of a car hitting the hand. Today, the “Driver’s fracture” is seen in golfers who hit the ground rather than the ball so we can say that it is still a driver’s fracture as there is a club named a driver.

At the distal aspect of the carpals, you find the metacarpals. These are referred to as their number with the thumb being the first and the little finger being five. In clinic a mid-shaft fracture of the fourth and fifth metacarpal was referred traditionally a boxer’s fracture. The reason that the boxer’s fracture occurs is mostly because of the angle that the force travels through the bones during a punch.

The fingers, which are called the phalanges, are usually made of three bones named for their position. Each part of a finger is called a phalanx and can be Proximal phalanx, middle phalanx and distal phalanx. The only finger which is different is the first phalanges which is made of only a proximal and distal phalanx.

14. Label the following on the pictures:

- | | | |
|---|---|---|
| <p>A. Carpals</p> <ul style="list-style-type: none"> a. Scaphoid b. Lunate c. Triquetrum, d. Pisiform, e. Trapezium, | <ul style="list-style-type: none"> f. Trapezoid g. Capitate h. Hamate <p>B. Metacarpals(1-5)</p> <p>C. Phalanges</p> | <ul style="list-style-type: none"> a. Proximal b. Middle c. Distal |
|---|---|---|



15. Using the hand model, can you give a mechanical reason why the second and third would not break as easy if used for a punch than the fourth and fifth?
16. Which finger only has two phanages?
17. Which phalanx is missing?
18. What do each of the following mean?
 - a. Proximal
 - b. Distal
 - c. Spine
 - d. Head
 - e. Neck
 - f. Shaft
 - g. Tubercle
 - h. Fossa
 - i. Epi
 - j. Condyle

The lower limbs:

Legs are divided like the arms with distinct regions. The sacrum, which is part of the axial skeletal system, is attached to a large wing-shaped bone. The hip bones, or Os Coxa, was three bones that fused together. These are the Ilium, Ischium, and pubic bones. The top is formed by the ilium (which means abdomen) the inferior posterior is called the Ischium and the inferior anterior is called the pubic bone. If you feel the skeletons hip bone on the superior aspect, is the smooth crest called the Iliac Crest. If a line is drawn between the two Iliac crest and follow it to the spine, one reaches the L4/L5 intervertebral space which is why it is a vital clinical landmark.

The Iliac has many other landmarks such as on the anterior portion of the bone we find two spine-like projections. As one is above the other, they are called the Anterior Superior and Anterior Inferior iliac spines. On the posterior side of this bone, we have two other projections called the Posterior Superior and Inferior Iliac Spines. Inferior to the Posterior Inferior Iliac Spine is a notch called the Sciatic Notch which leads to where the Ischium begins.

On the lateral side of the bone are three lines. Halfway between the Posterior superior iliac spine and the Sciatic Notch, is a line which curves towards the Iliac Crest called the Posterior Gluteal line. Inferior to the Posterior Gluteal line there is a line which starts at the Sciatic Notch and curves up towards the Anterior Superior Iliac Spine called the Middle Gluteal line. Inferior to the Middle Gluteal Line we can see a line that begins at the lower aspect of the Sciatic Notch and moves to the notch between the Anterior Superior Iliac Spine and the anterior inferior iliac spine.

Pointing anteriorly from the inferior side the Os Coxae is the Pubic bone. This bone is important in Obstetrics as it is used to begin to measure the uterus. The Pubic tubercle attaches to the Pubic tubercle of the other OS Coxa in the midline forming the Pubic symphysis. As it is held together by fibrocartilage, at time it tears during vaginal deliveries leading to various complications. From the Pubic tubercle, you can move superior to the Superior Ramus (meaning hand) of the pubic bone which connects to the Ilium on the superior side and the Ischium on the posterior side. If one looks at the pubic tubercle and moves inferior and posterior, one find the Inferior ramus of the Pubic bone which is fused to the Ischial ramus.

Inferior to the sciatic notch is a spine of the ischium. Below the Ischial spine is a notch called the lesser Sciatic notch which is followed by the larger Ischial tuberosity. The Ischium has a ramus which attaches to the Pubic bone. The three bone together form a cup called the acetabulum and the Pubic bone and Ischium form the borders of the Obturator foramen.

If one were to look at the anterior most of the Os Coxa together, one would see the pelvic girdle. Most anatomical structures can be recognized from its lateral view. Yet there are some that are unique to the

anterior view only. The first thing to see is the rim made up of the iliac crest and the pubic symphysis. That rim is called the false pelvis. There is also a visible line which separates the Ala or wing of the Ilium from the body. That line is the Arcuate line of the ilium and is the border of the true pelvis

The pelvis is important in forensics and anthropology as it is used to determine the sex of a skeleton. In men, the false pelvis is taller so appears narrower. Another difference is in the angle of the inferior Pubic ramus. In men the angle is less than 70 degrees while in women it can range from 90 to 100 degrees. This difference will make the true pelvis, wider and more oval in women.

The Os coxae has many invaluable anatomical sites which can help in orientation. The Iliac crest is one which in clinic is used to find vertebral level Lumbar 4-5, where spinal taps are performed. The Anterior Superior Iliac Spine and the pubic tuberosity are used to determine where the leg begins. The Posterior Superior Iliac Spine is used to determine where in the gluteal region to give an injection. It would be from the Posterior Superior Iliac Spine to one third the distance of the gluteal muscle.

19. In the image provided, label the following:

A. Ilium

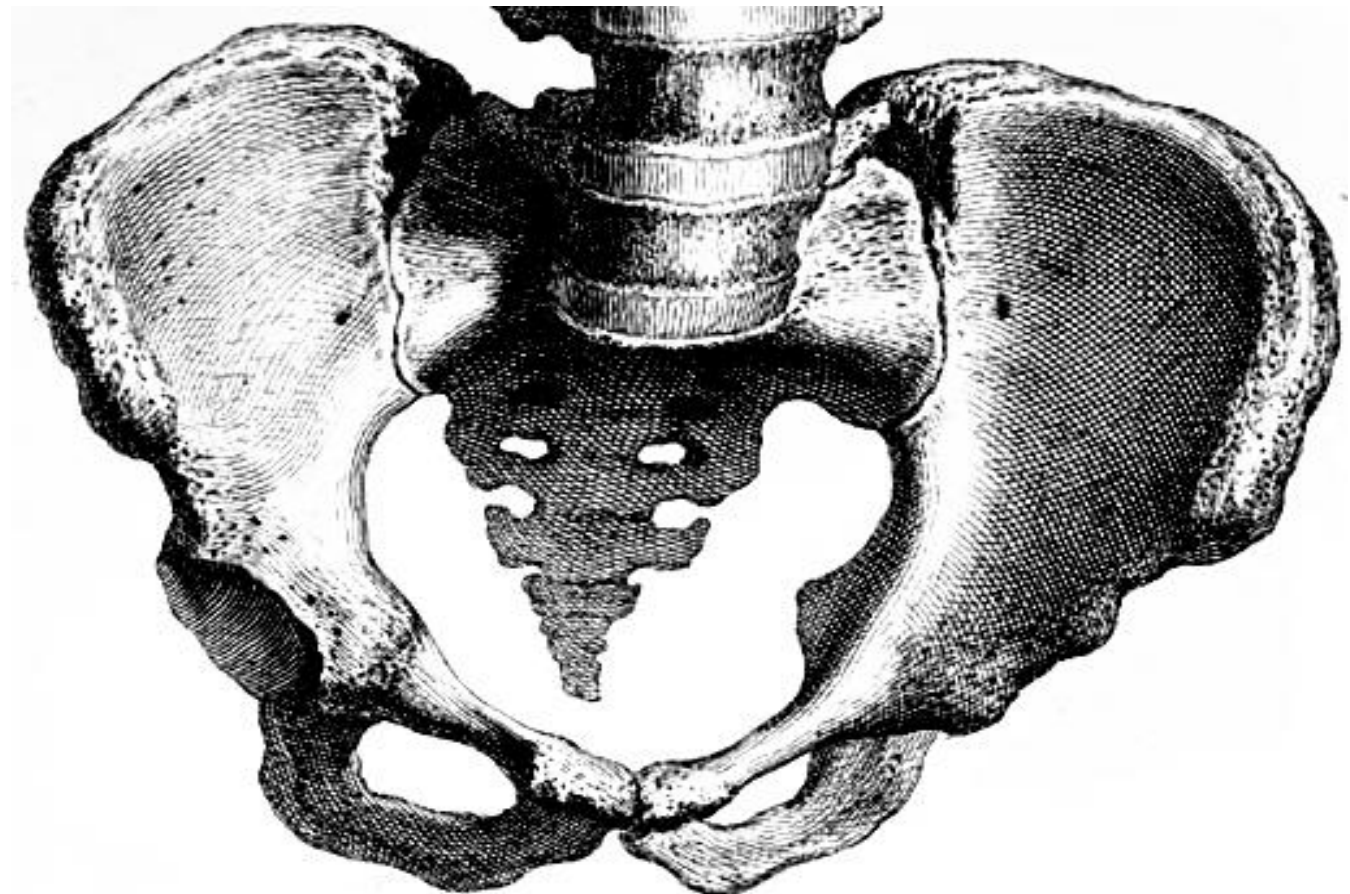
- a. Anterior superior iliac spine
- b. Anterior inferior iliac spine
- c. Iliac crest
- d. Posterior superior iliac spine
- e. Greater sciatic notch
- f. False pelvis
- g. True pelvis
- h. Arcuate line

B. Pubis

- a. Superior ramus
- b. Inferior ramus
- c. Pubic symphysis

C. Ischium

- a. Ischial spine
- b. Lesser Sciatic notch
- c. Ischial tuberosity
- d. Ramus of ischium



Inside the Acetabulum of the Os Coxa, we find the head of the Femur. One can compare the femoroacetabular joint to the Glenohumeral joint. While both are ball and socket joints, one can see the the Femoroacetabular joint is more stable while the glenohumeral joint is more mobile. On the round head of the femur, one can see a divot called the Fovea Capitis (capitis is head) which will have a ligament called the ligamentum teres.

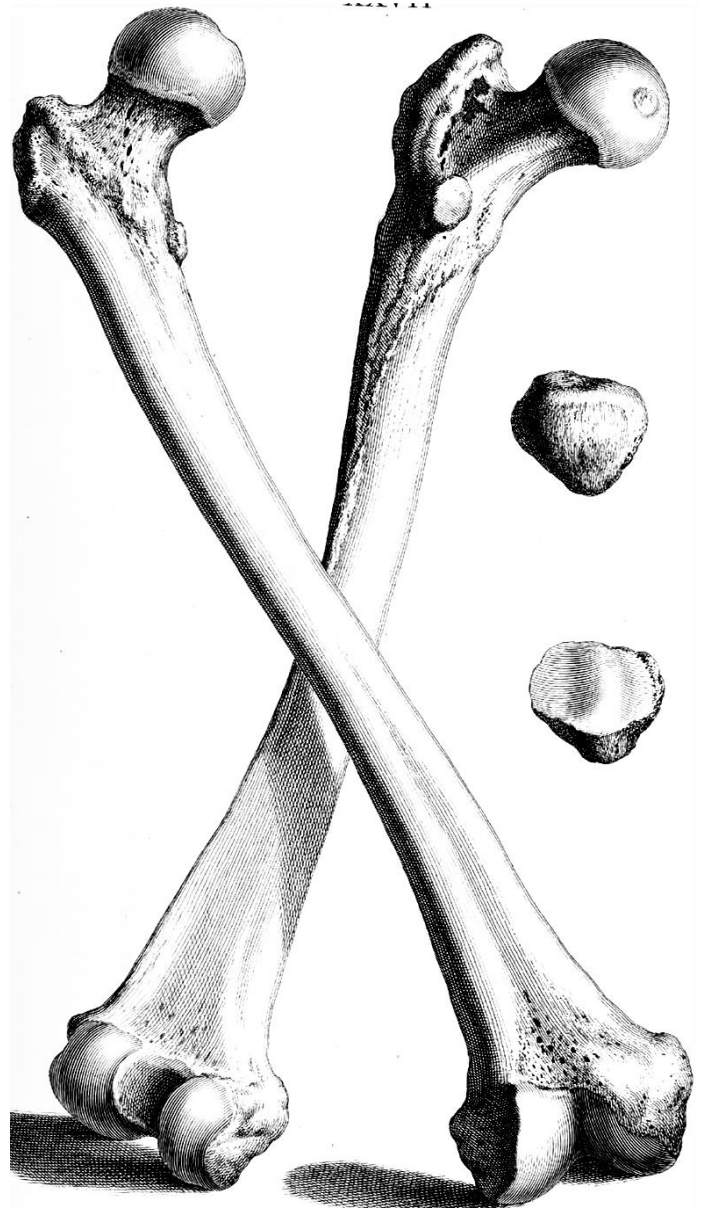
Distal to the head, we find the neck of the Femur which connects near two large lumps called Trochanters. The larger one on the superior part, is called the Greater Trochanter and the lower, smaller one is the Lesser Trochanter. On the anterior side of the femur, between the Trochanters is a line called the intertrochanteric line. On the posterior side, we can find a large lump running between then called the intertrochanteric Crest.

Moving down the Femoral shaft the Epiphysis has two knuckled-like rounded projections called the Condyles. As one is medial, and the other is lateral they are the medial and lateral condyles. Just lateral and superior to the condyles are the medial and lateral epicondyles. Just anterior to the condyles of the femur, you can find the Patella. This is an irregular shaped bone with an apex, a sharp point pointing downward, a base on the top and an articular surface. The Medial and lateral epicondyles can be palpated on a living human, so are sites used by orthopedic surgeons to determine where to cut to find the femoral neck. The next place that the femur can be palpated is and follow it to the knee joint you will feel a pair of blunt wings on the lateral and medial aspect of the femur.

20. Label on the Proximal end of the femur
 - a. femoral head
 - b. Fovea Capitis
 - c. Neck
 - d. greater and lesser trochanters
 - e. trochanteric line
 - f. trochanteric crest
 - g. femoral shaft

21. Follow the femur to the distal end and label the following structures:
 - a. Epicondyles
 - b. Condyles
 - c. Intercondylar fossa
 - d. Linea aspera
 - e. Popliteal surface

22. Label the following on the patella
 - a. Apex
 - b. Base
 - c. Articulate surface



23. On a skeleton feel the iliac crest and determine what lumbar level it would lead you to?

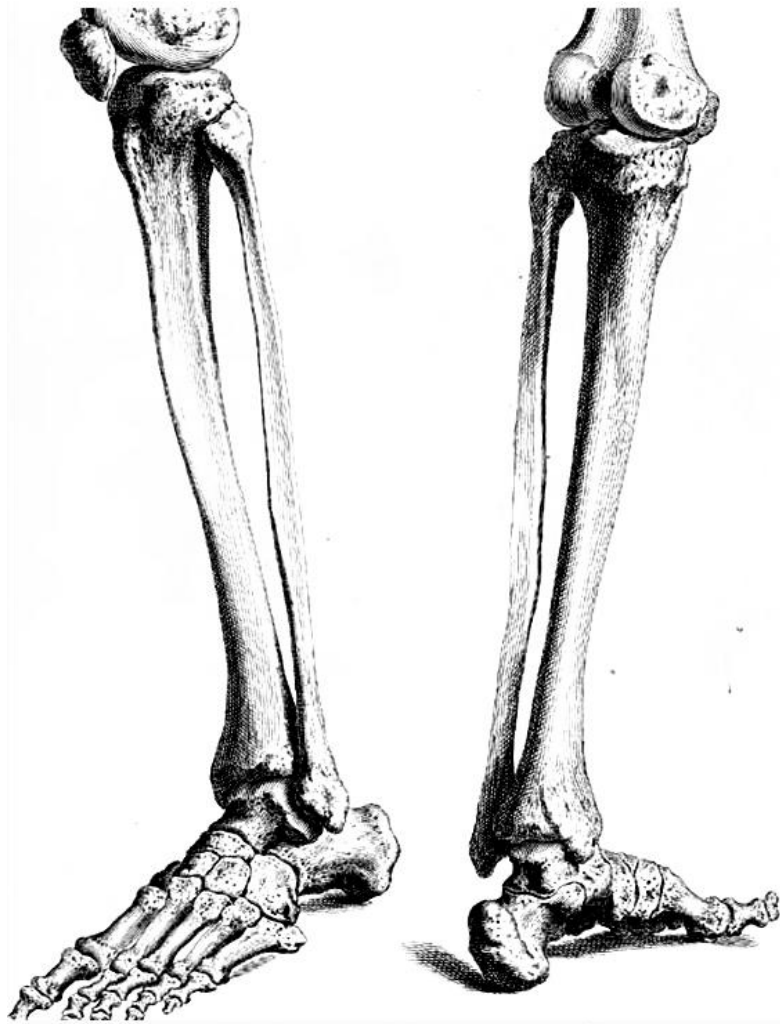
24. Which bones makes the Acetabulum?
25. Look at the hip joint and compare it to the shoulder. Which seems more secure?
26. Move your glenohumeral joint around then your hip joint, which one has more movement?
27. What are the blunt projections on the sides of the knee called?

Distal to the femur are two bones, the larger one that is shaped almost like a “T” is called the Tibia and is the weight bearing bone of the lower leg. Lying next to it is the fibula a smaller bone which is needed to rotate the ankle. One can tell themselves that the little bone that lies next to the Tibia is the FIBula.

The Tibia can be palpated almost its entire length. On the proximal end of the Tibia as a flat area called the Tibial Plateau. In the middle of it there is an elevated area in the middle of the plateau called the Intercondylar Eminence. Based on its name you understand that it will be in between the condyles of the femur. Anterior most on the proximal end, you will find a lump of bone called the Tibial Tuberosity. It can be easily palpated and is clinically important as many times children can avulse the Tibial tuberosity leading to a condition known as Osgood-Schlatter syndrome.

The shaft of the tibia can be palpated down to the medial side of the ankle joint where it ends at a large bump called the Medial Malleolus. As the Tibia is the weight bearing joint and is not completely covered by muscle, it tends to have a few different fractures. The most common is a fracture of the tibial tuberosity called a Schatzker fracture. The Shatzker occurs either from direct trauma to the lateral side of the tibial plateau or a fall or jump from high area.

28. Label the following:
 - a. Tibia
 1. Tibial plateau
 2. Tibial tuberosity
 3. Intercondylar eminence
 4. Medial malleolus
 - b. Fibula
 1. Head
 2. Lateral malleolus



There are two other fractures of the tibia at the diaphysis. The first is known as “Bumper bump.” It was originally named as a car could hit a pedestrian on the tibia with its bumper leading to a direct fracture. The second of these fractures is called a “Boot” fracture. The Boot fracture is a stress fracture caused by the trauma of moving in a ridged boot over prolonged periods of time.

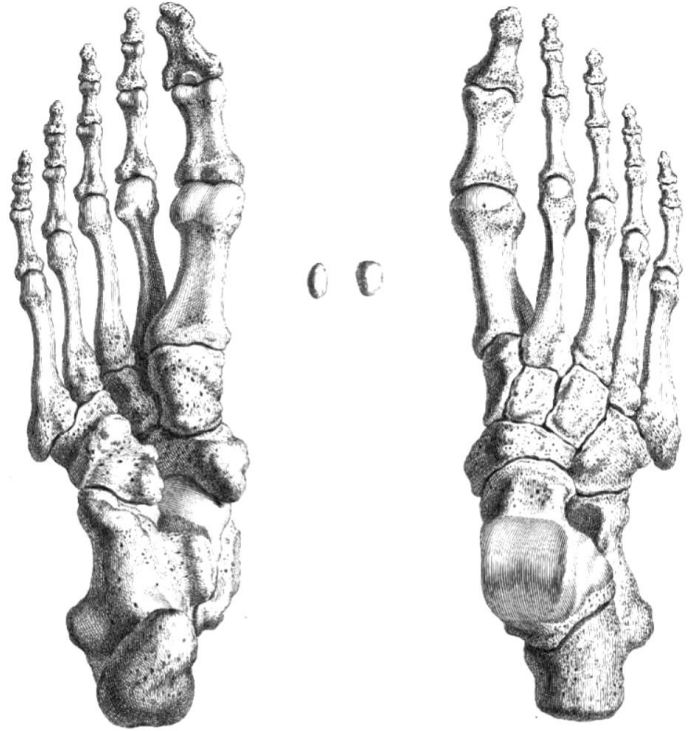
Lying lateral to the Tibia is the fibula which can be palpated at the distal end on the lateral side of the ankle. That bony projection is called the Lateral malleolus. The main fracture of the fibula is due to rotation the ankle which cause the lateral malleolus to break. Still if one were to look at the proximal end of the fibula, one can see the head of the fibula.

29. What bone does the femur articulate at its distal end?
30. At the anterior superior part of the Tibia is a bump, what is that process called?
31. What is the name of the distal end of the tibia that can be palpated at the ankle?
32. Does the Fibula lie medial or lateral to the Tibia?
33. What is the bumps palpated at the lateral side of the ankle?

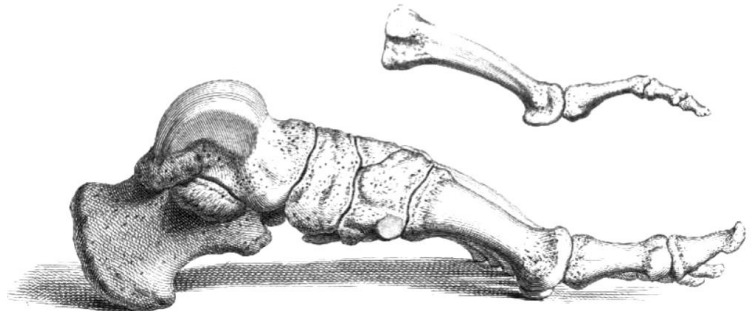
Distal to the tibia and fibula, you come to the bones of the ankle collectively called the tarsals. The tarsal which is supporting the weight from the tibia is called the Talus. It is held up Calcaneus posteriorly and the Medial longitudinal arch continue anteriorly to the Navicular bone then the three Cuneiform bones (Medial, intermediate, and Lateral) which continued down the first to the third metatarsals. The Lateral Longitudinal arch is formed by the Calcaneus, Cuboidal and the 4th and 5th metacarpals.

The metatarsals are numbered the same way as the metacarpals with the first metatarsal being the largest one and moving down to the fifth metatarsal which has a styloid process. All metacarpals have a base, at the proximal end and a head with a condyle at the distal end. This is followed by the phalanges which are the toes in this case which are similar in arrangement as the fingers.

34. On the picture label the following:
- Talus
 - Calcaneus
 - Cuneiforms
 - Lateral
 - Intermediate
 - medial
 - Cuboidal
 - Metatarsals (1-5)
 - Phalanges
 - Proximal
 - Middle
 - Distal
35. Which phalanx is the big toe missing?



Throughout the skeletal system, there are many places where you can palpate bony structures to determine locations via landmarks. Some of these landmarks can be used as sites for interosseous infusions (IO). IOs are processes of injecting directly into the bone marrow to provide a non-collapsible opening to the Venous system. This is a way to provide fluids and medications when other routes of admission are not possible. At times it seems as if IO is superior to both intramuscular and intravenous.



- Below are sites used for IO, determine how a clinician would be able to feel for the following sites:
 - Proximal humerus
 - Proximal tibia medial to the tibial tuberosity
 - Distal tibia
 - Lateral condyle of Femur
 - Iliac crest
 - Sternum