

# Exercise 5: The Appendicular Skeleton and Joints



Figure 5.1: This statue exemplifies the importance of the appendicular skeleton and joints in body movement.  
Source: [https://commons.wikimedia.org/wiki/Category:Yoga#/media/File:1\\_red\\_yoga\\_statue.jpg](https://commons.wikimedia.org/wiki/Category:Yoga#/media/File:1_red_yoga_statue.jpg)

## Exercise 5 Learning Goals

After completing this lab, you should be able to:

- Recognize and define parts of long bones
- Understand the major function of appendicular bones and their joints
- Identify bones of the appendicular skeleton
- Identify landmarks on appendicular bones
- Define joints based on structure and function
- Identify movements at synovial joints

## Pre-Lab Activity 5.1: Parts of Long Bones

We often think of bones as hard, rigid nonliving tissue because we examine this unique connective tissue after death or outside of body. Bone is a dynamic living tissue that provides structural support and protects important soft tissues. Describe the following external features of long bone:

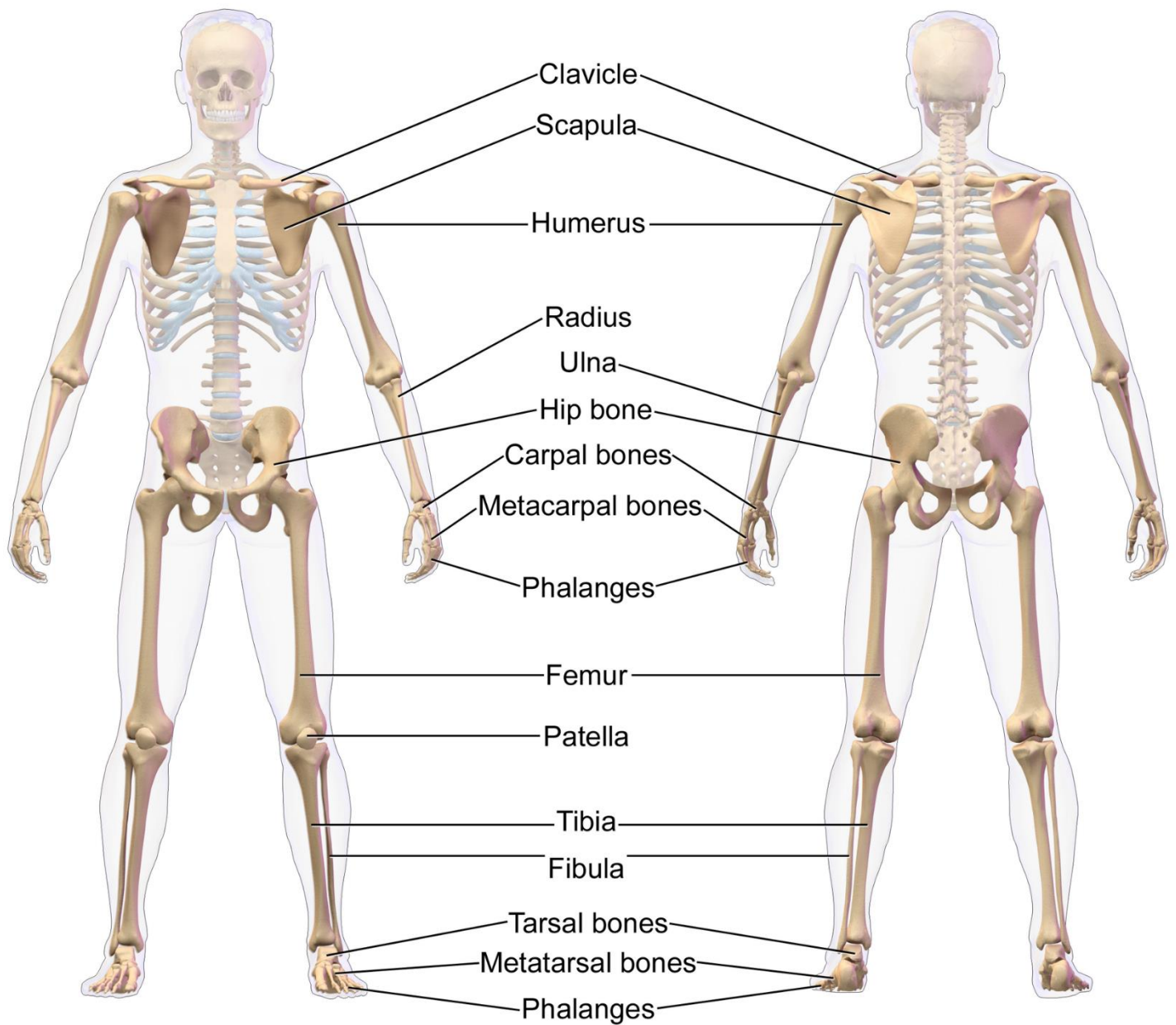
<b>Feature</b>	<b>Description</b>	<b>Function</b>
<b>Diaphysis</b>	<b>The long cylindrical center shaft of a long bone</b>	<b>Forms the medullary cavity where bone marrow is found</b>
<b>Epiphysis</b>		
<b>Metaphysis</b>		
<b>Articular Cartilage</b>		
<b>Periosteum</b>		
<b>Medullary Cavity</b>		
<b>Endosteum</b>		

## Pre-Lab Activity 5.2: Introduction to the Appendicular Skeleton

The appendicular skeleton connects the upper and lower limbs to the axial skeleton via the shoulder and pelvic girdles. In this lab, you will learn not only the names of these bones, but how they articulate with one another and the bony landmarks that reside on them. Familiarize yourself with the bones below and how they articulate with one another. Complete the table below describing the shape of each bone and how each contributes to movement.

<b>Bone(s)</b>	<b>Articulates with...</b>	<b>Weakest point/Clinical Significance</b>	<b>Shape</b>
<b>Clavicle</b>	<b>Scapula and sternum</b>	<b>The two curved areas</b>	<b>S-shaped</b>
<b>Scapula</b>			
<b>Humerus</b>			

<b>Radius</b>			
<b>Sacrum</b>			
<b>Ulna</b>			
<b>Carpals</b>			
<b>Metacarpals</b>			
<b>Phalanges of the Hand</b>			
<b>Ilium</b>			
<b>Ischium</b>			
<b>Pubis</b>			
<b>Femur</b>			
<b>Tibia</b>			
<b>Fibula</b>			
<b>Tarsals</b>			
<b>Metatarsal</b>			
<b>Phalanges of the Foot</b>			



# The Appendicular Skeleton

## Pre-Lab Activity 5.3: Appendicular Skeleton Questions

How many total bones are in the appendicular system?

What are the functions of the pectoral (shoulder) and pelvic girdles?

List the specific bones and number of each that make up the upper limbs.

List the specific bones and number of each that make up the lower limbs.

### Pre-Lab Activity 5.4: Joints

Joints are classified in two ways: by structure and function. Describe and give examples of each joint classification listed below.

<b>Structural Classification</b>	<b>Description</b>	<b>Example</b>
<b>Fibrous</b>	<b>Lacks a space and bones are held together by connective tissue</b>	<b>Skull sutures</b>
<b>Cartilaginous</b>		
<b>Synovial</b>		

<b>Functional Classification</b>	<b>Description</b>	<b>Example</b>
<b>Synarthrosis</b>	<b>Immovable joints</b>	<b>Skull sutures</b>
<b>Amphiarthrosis</b>		
<b>Diarthrosis</b>		

List all the structures characteristic of synovial joints.

## Pre-Lab Activity 5.5: Synovial Joint Movements

Specific terminology is used to describe movement at synovial joints. The four movement categories include:

- 1) gliding movements observed between flat bones which allow for back-and -forth and side- to -side motion,
- 2) angular movements which describe increasing or decreasing angles at joints between articulating bones,
- 3) rotation which involves a bone rotating around its own longitudinal axis, and
- 4) special movements which occur at specific joints.

Describe each of the movements listed in the table below and give examples of joints where such movements occur.

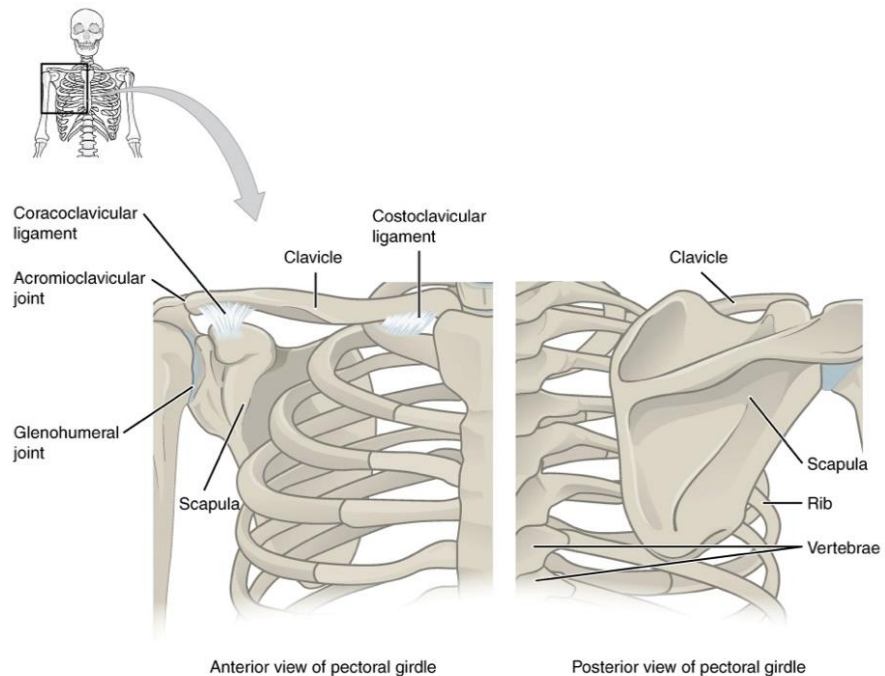
<b>Movement</b>	<b>Description</b>	<b>Joints</b>
<b>Flexion</b>	<b>A decrease in the angle between bones forming a joint</b>	<b>elbow</b>
<b>Extension</b>		
<b>Hyperextension</b>		
<b>Abduction</b>		
<b>Adduction</b>		
<b>Rotation</b>		
<b>Inversion</b>		
<b>Eversion</b>		
<b>Planter Flexion</b>		
<b>Dorsiflexion</b>		

## Lab Activity 5.1: The Pectoral (Shoulder) Girdle

The pectoral (shoulder) girdle is composed of two bones, the **clavicle** and **scapula** which together function as the proximal attachment points for the arms to the axial skeleton. The head of the humerus (arm) articulates with the shallow glenoid cavity of the scapula. This design sacrifices stability for increased mobility at the shoulder girdle.

Activity 5.1.1 Label the clavicle and the scapula including specific features listed below.

Activity 5.1.2: Using the disarticulated skeleton, determine how to identify the anterior from posterior surface of each bone.



### Clavicle (right and left)

**Acromial end**

**Sternal end**

### Scapula (right and left)

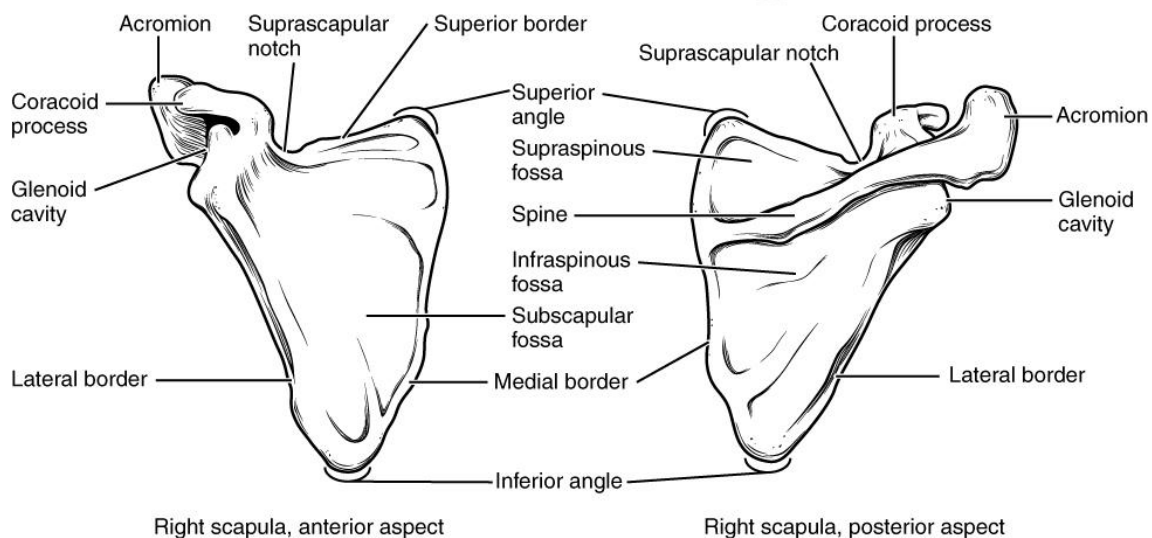
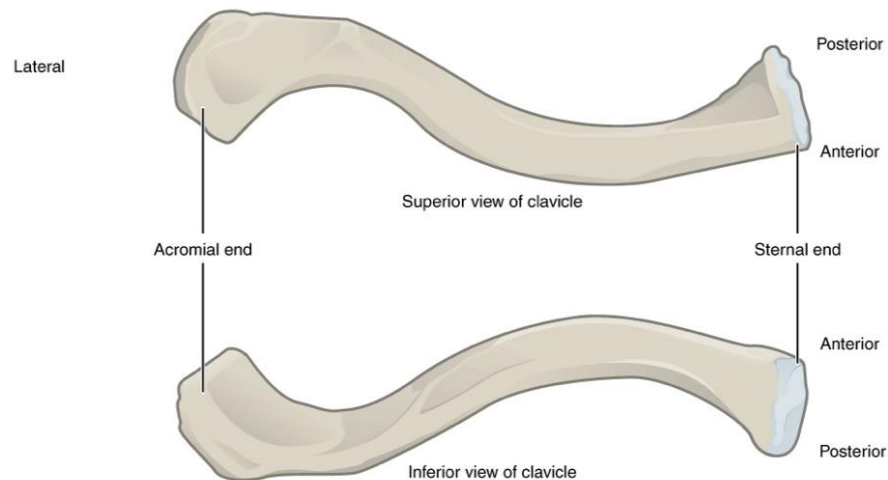
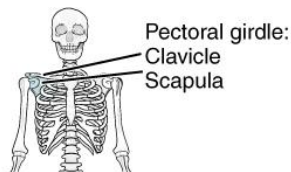
**Acromion**

**Coronoid tubercle**

**Spine**

**Glenoid cavity**

**Coracoid process**





## Activity 5.2: Bones of the Arm

The **humerus** is a long bone that articulates proximally with the glenoid cavity of the scapula and distally with the radius and ulna. It is the longest and largest bone of the upper limbs. The **radius** is the smaller lateral bone of the forearm articulating with the capitulum proximally and the carpal bones distally. The **ulna** is the medial bone of the forearm which articulates with the trochlea proximally and the carpal bones distally. Identify and label the humerus, radius and ulna including landmarks.

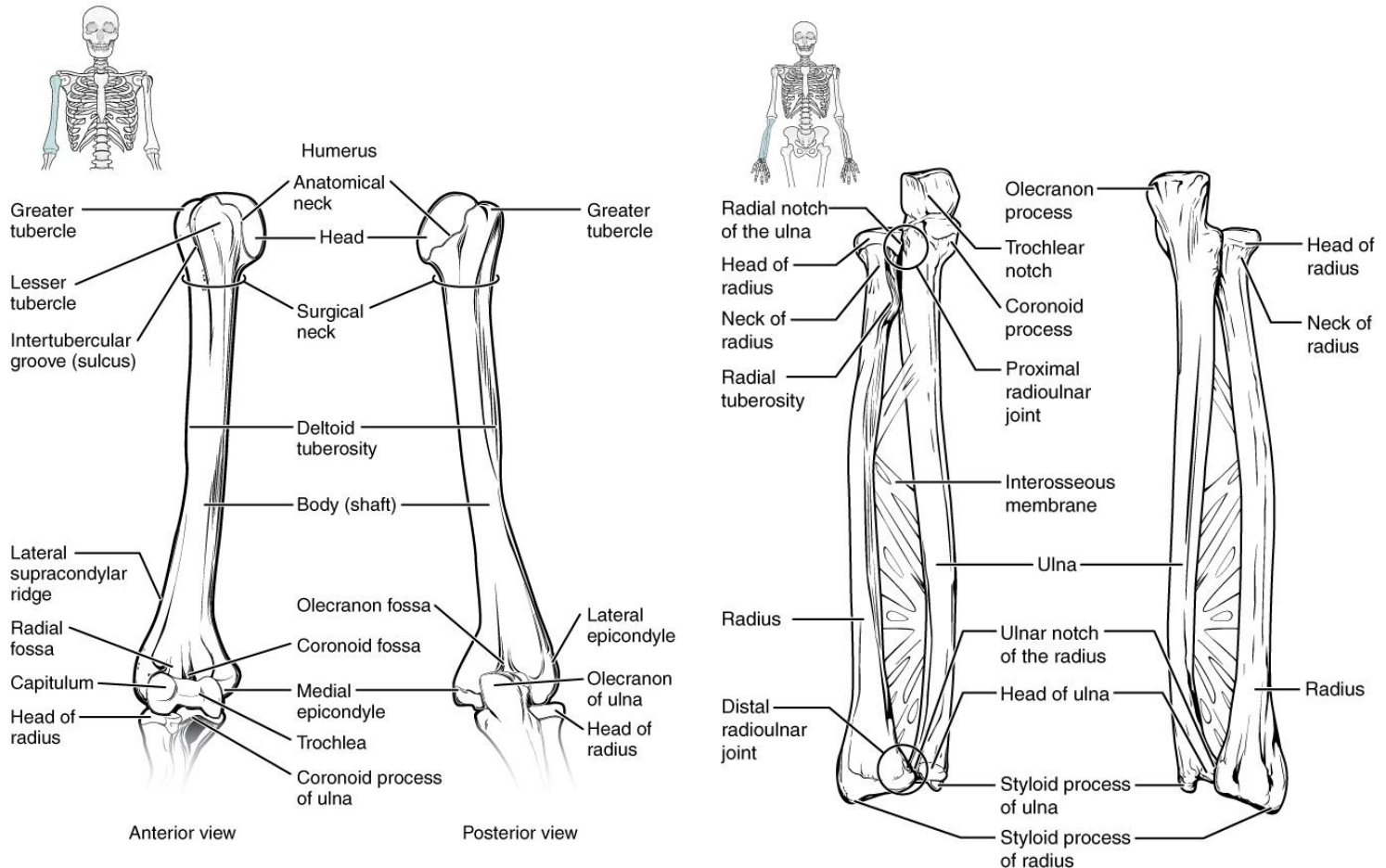


Image 5. Source: OpenStax Anatomy and Physiology

Activity 5.2.1: Identify each bone of the arm and its specific markings.

Activity 5.2.2: Using the disarticulated skeleton, determine how to identify the anterior from posterior surface of each bone.

### Humerus (right and left)

Head

Anatomical neck

Greater tubercle

Surgical neck

Intertubercular sulcus

Deltoid tuberosity

Lateral and Medial Epicondyles

Trochlea

Capitulum

Olecranon fossa

### Radius (right and left)

Head

Radial Tuberosity

Styloid process of radius

### Ulna (right and left)

Olecranon process

Trochlear notch

Radial notch

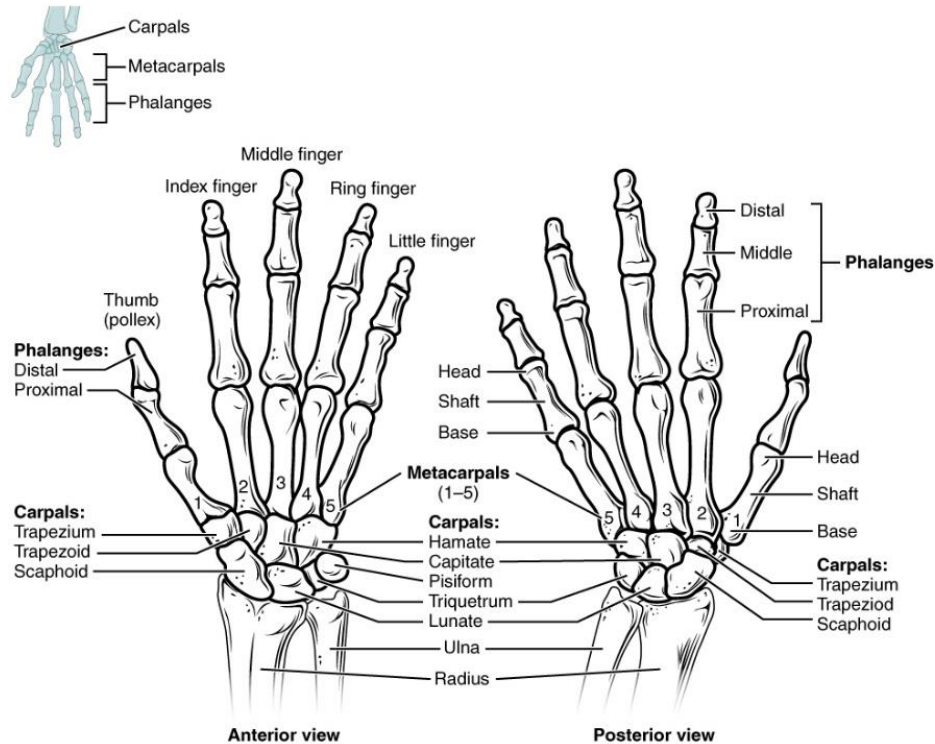
Head

Styloid process of ulna



Activity 5.3: Bones of the Wrist and Hand.

The bones of the wrist are collectively known as carpal bones and these eight short bones are held together by ligaments. The bones are arranged in two rows of four bones. The proximal row from lateral to medial includes the **scaphoid** (boat-shaped), **lunate** (moon-shaped), **triquetrum** (three-cornered), and **pisiform** (shaped like a pea). The distal row from lateral to medial includes the **trapezium** (four-sided), **trapezoid** (four-sided), **capitate** (shaped like a head), and **hamate** (hook-shaped).



Activity 5.3.1: Come up with your own mnemonic for remembering the order of the carpal bones and write it in the space provided below.

Activity 5.3.2: Identify the carpal bones using the hand on the whole skeleton or the disarticulated hand.

Scaphoid (left and right)	Trapezium (left and right)
Lunate (left and right)	Trapezoid (left and right)
Triquetrum (left and right)	Capitate (left and right)
Pisiform (left and right)	Hamate (left and right)

List the wrist bones which articulate with the distal end of the radius and ulna.

What is the joint between two carpal bones called?

The five **metacarpals** form the palm of the hand. These long bones articulate with the proximal phalanx. The metacarpal bones do not have specific names but are labeled 1-5 (I-V) from lateral to medial. Identify the following features of the metacarpal bones.

<b>Base</b>
<b>Shaft</b>
<b>Head</b>

What is the name of the joint between the distal carpal bones and the metacarpals?

How are metacarpals most commonly fractured?

The **phalanges** are the long bones that make up the digits on each hand. The digits are numbered 1-5 from lateral to medial. The 4 fingers are composed of a proximal, middle and distal **phalanx**. The pollex (thumb) is only composed of a proximal and distal phalanx. Identify the proximal, middle and distal phalanx for each digit.

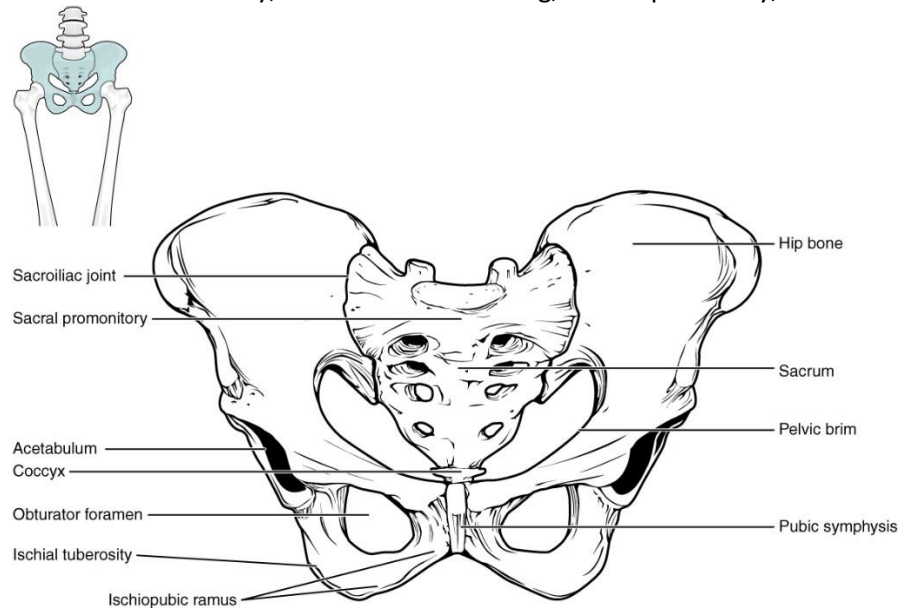
How many phalanges are on each hand?

Name the joint between the metacarpals and the digits?

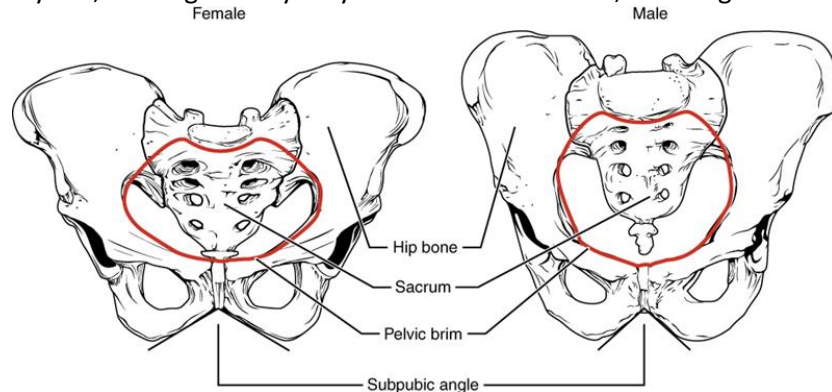
Name the joint between the phalanges?

## 5.4 The Pelvic Girdle

Formed by the union of the two hip bones (os coxa) anteriorly at the pubic symphysis and posteriorly to the sacrum and coccyx, the **pelvis** is a strong, stable structure built for a lifetime of load-bearing. The **pelvic girdle** much like the shoulder girdle, is designed for the support and attachment of limbs to the body, specifically the lower limbs. By uniting with the sacral portion of the vertebral column to the coxal bones, the weight of the trunk and upper limbs can be shifted into either lower limb simultaneously, such as when standing, or independently, as occurs during walking.



The pelvis is divided into two regions: the **true pelvis** and **false pelvis**. From the top of the **pelvic brim** or **pelvic inlet** to the superior most points of the hip bone are the false pelvis or **greater pelvis**. The term 'false' is applied to this space because it does not contain pelvic organs, but rather portions of the lower abdominal organs. Below the pelvic brim extending to the **pelvic outlet**, is the smaller true pelvis, known as the **lesser pelvis**. One method of determining the sex of a skeleton in forensic bone analysis is identifying the unique characteristics of the female versus male pelvis. As shown in the figure below, the pelvic brim is wider and shallower in the female compared to males, which have a significantly narrower and more circular pelvic brim. The shape of the female pelvis allows for the distribution of weight when carrying a fetus during pregnancy and passage of the infant's large head during childbirth. Finally, the inferior angle formed by the attachment of the pubic bones to one another at the pubic symphysis is the **subpubic angle**. In women this angle is typically 90°, although it may vary from 70-90°. For men, this range is lower, typically 50-80°.



Activity 5.4.1: Identify and label the bones/structures which make up the pelvis and pelvic girdle using the whole skeleton

Left os coxae  
Right os coxae  
Sacrum  
Coccyx

Sacral promontory  
Pelvic brim  
Obturator Foramen  
Pubic symphysis

Sacroiliac joints

What are the common structures shared by the pelvis and pelvic girdle? How are they different?

Why is the pelvis shaped like it is? What are the main differences between the female versus male pelvis? What is the purpose for these differences?

Activity 5.4.2: Identify the landmarks and the regions of the false pelvis and true pelvis. Look at a torso model. Identify which organs and structures would you expect to find in each region of the pelvis.

Pelvic Region	Organs Located in Region

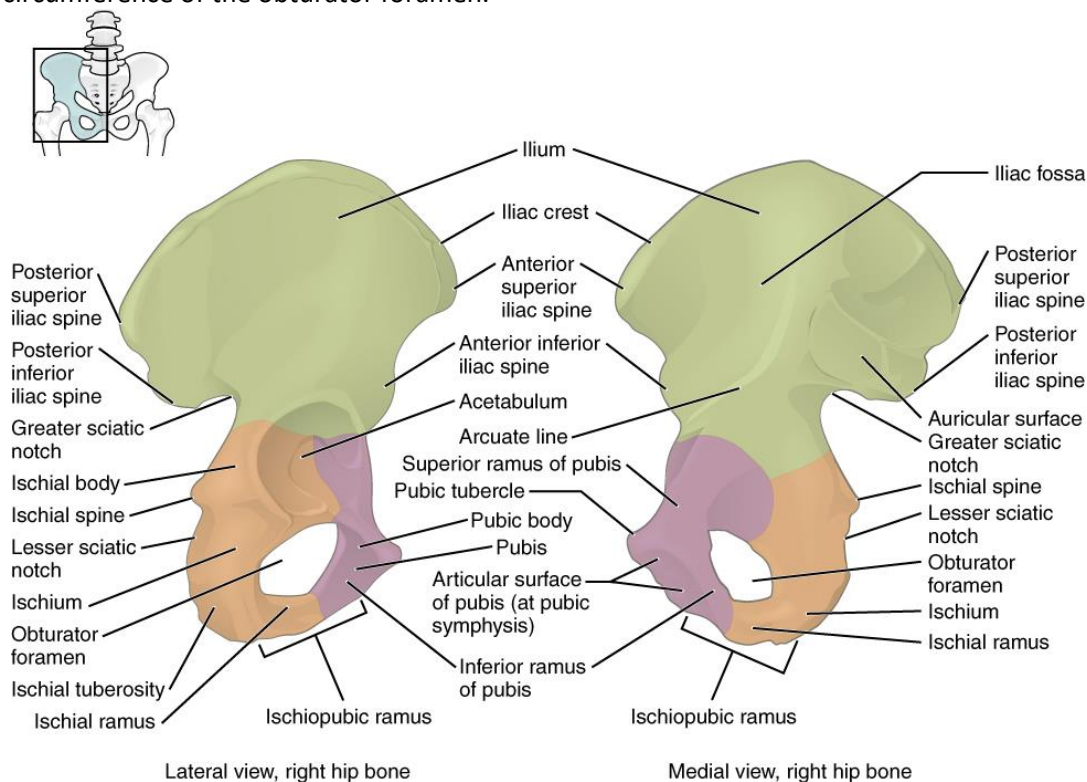
How does the structure of the pelvis contribute to functions of the human body? Think: skeletal muscles, internal organs/structures which must “work” in and around the pelvis.

## 5.5 The Hip: Ilium, Ischium, and Pubis

The right and left **os coxa** (hip bone; coxal bone) are formed by three separate bones which fuse during in early adulthood. Thus, in the mature adult skeleton, the os coxa retain their previous designations despite being one structure. Superiorly, the **ilium** of the os coxa has a distinctive upper ridged portion called the **iliac crest** formed by the **wing of the ilium** (or ala). The ilium joins posteriorly with the sacrum, right and left, forming the **sacroiliac joint**. This is frequently the site of low back pain in pregnant and older women due to hormonal effects on the ligaments stabilizing the joint. Adjacent to the sacroiliac joint on either side is the **iliac tuberosity**, a roughened site of muscle origin and ligament attachment. Both the **anterior** and **posterior** aspects of the ilium have **superior** and **inferior iliac spines** which serve as attachment points for many muscles and ligaments. The **anterior superior iliac spine** is often seen as a feature of surface anatomy and is easily felt when palpating the anterolateral sides of the lower abdominal/upper pelvic region. Similarly, the **posterior superior iliac spine** may be observed as two identical indentations on the mid-lower back (dimples of Venus). Additionally, the posterior portion of the ilium features a deep notch below its inferior spine called the **greater sciatic notch**, where the sciatic nerve, passes through.

Joining with the ilium inferior and posteriorly is the **ischium** (seat bone), identified by a thick **body** and large, curving **ischial ramus**. The **obturator foramen** is formed by the medial aspect of the ischium. Laterally, the **ischial spine** runs superior and inferiorly ending at the significant, but still aptly named **lesser sciatic notch**.

The superomedial and inferomedial portions of the ischium join with the third bone of the os coxa, the **pubis**, to form the remaining portion of the acetabulum and the **ischiopubic ramus** respectively. The anterior portion of each pubis join at their **articular surfaces** to form the **pubic symphysis**. The lateral aspects of the **superior** and **inferior pubic rami** form the remaining circumference of the obturator foramen.



Examine the right and left coxal bones from the disarticulated skeleton and identify the following:

**Ilium (R&L)**  
**Iliac crest**  
**Ala**  
**Greater sciatic notch**  
**Acetabulum**

**Ischium (R&L)**  
**Ischial spine**  
**Lesser sciatic notch**  
**Ramus**  
**Acetabulum**

**Pubis (R&L)**  
**Articular surface**  
**Superior ramus**  
**Inferior ramus**  
**Acetabulum**

## 5.6 Bone of the Thigh

The upper portion of the lower limb, called the **thigh**, contains only one bone, the **femur**. Since the femur has no additional bony support from the hip to the knee joint, it is the single strongest bone found in the human body. Additionally, the femur typically contributes to more than 25% of an individual's height. Thus, it is the only bone which can consistently and reliably be used to determine the height of a partial skeleton. This exceptionally large bone is divided into three main regions: the proximal end, the body (shaft), and distal end.

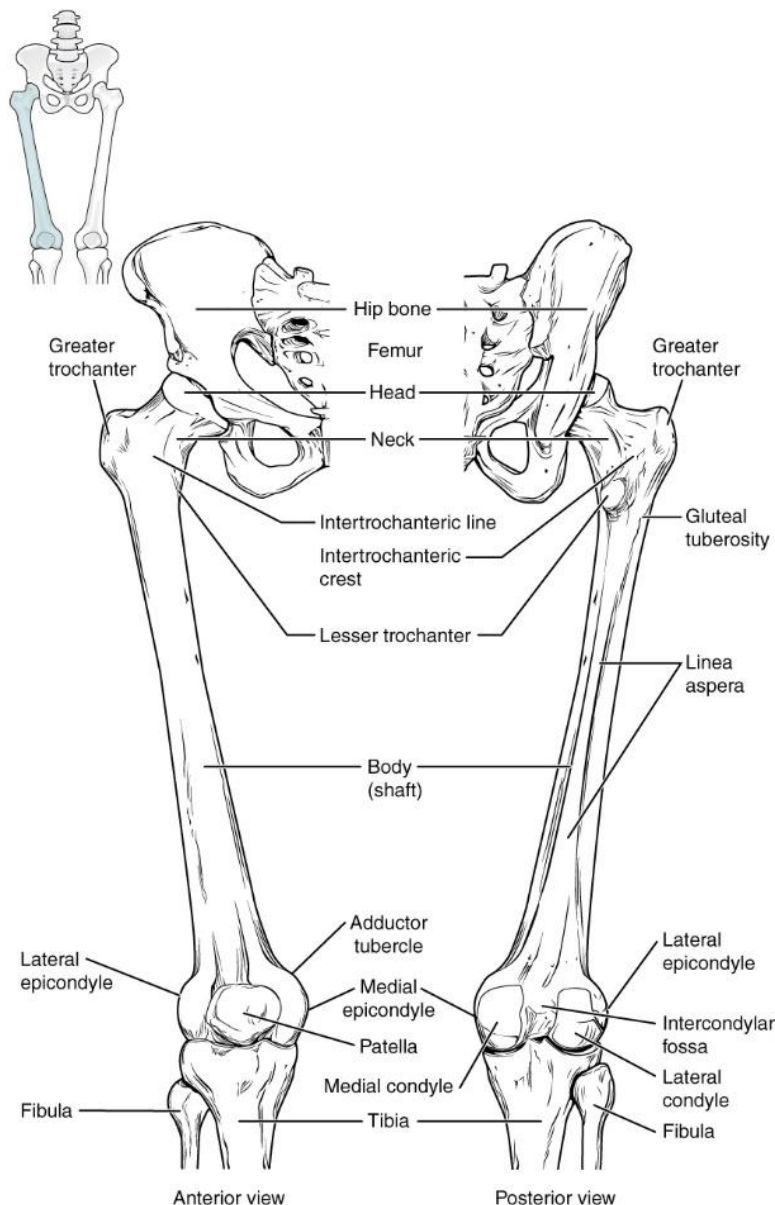
The proximal end of the femur articulates with the **acetabulum** of the hip bone. Additional cartilaginous structures surround the acetabulum, deepening its cup-like shape to securely hold the **head** of the femur. This deep, well-protected joint is why the hip is so strong and difficult to dislocate, unlike the shoulder. The medial surface of the

femoral head has a marked indentation called the **fovea capitis** where an artery supplying the femoral head enters. The fovea capitis is also the only surface of the femoral head not covered in hyaline cartilage. The common site of hip fracture is a narrowed region of the femur called the **neck**. The neck supports the femoral head and follows a slight lateral angle which connects to the long, narrow **body** or shaft of the femur. Found proximally on the lateral and posterior aspects of the neck are eminences of bone called the **greater and lesser trochanters**, specific to only the femur. The larger, and therefore greater trochanter is a site for muscle attachment and located directly opposite the femoral head. With portions beginning below both the greater and lesser trochanter, the roughened and slightly raised ridge of the **linea aspera** runs longitudinally down the posterior aspect of the femur shaft.

Emerging distally from the shaft of the femur are two large eminences, the **lateral and medial condyles** which form the superior articular structures of the knee (tibiofemoral joint). The shape of the condyles increases the size of the femur in either direction. The roughened spots immediately superior to each condyle are the **lateral and medial epicondyles**, which provide attachment points for several muscles and ligaments integral to knee stability. Anteriorly, the space between the condyles form the **patellar surface** which articulates with the kneecap or patella.

[Activity 5.6.1: Identify and label the specific bone markings of the femur.](#)

[Activity 5.6.2: Using the disarticulated skeleton, determine how to identify the anterior from posterior surface of the femur.](#)



**Femur (R & L)**

**Head**

**Neck**

**Fovea Capitis**

**Greater trochanter**

**Lesser trochanter**

**Linea aspera**

**Lateral condyle**

**Medial condyle**



## 5.7 The Kneecap-Patella

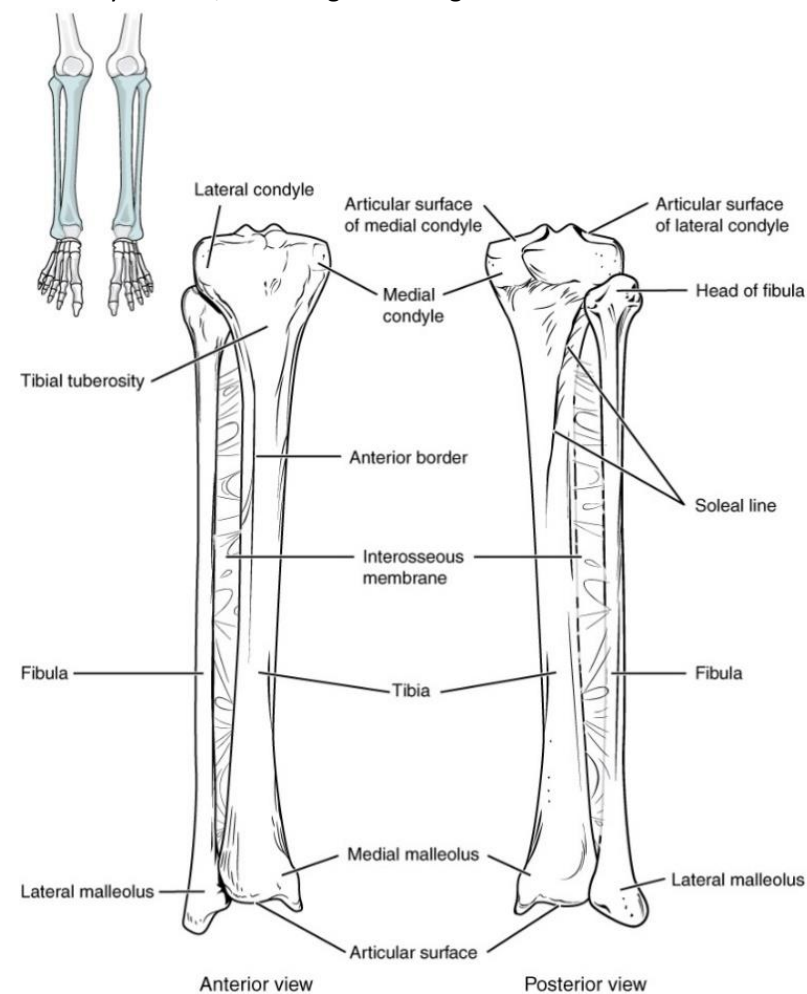
The best known and largest sesamoid bone in the body, the **patella** or kneecap, is found embedded in the large tendon of the quadriceps femoris group. The patella is a cartilaginous structure in infants and does not typically begin to ossify until early adolescence. It articulates with the anterior portion of the distal femur only (patellofemoral joint) and not the tibia.

Activity 5.7.1: Identify the patella and determine how to identify the anterior from posterior surface.

Name the 3 joints that form the knee. Which bones articulate with the patella?

## 5.8 Bones of the Leg

Beginning at the largest joint in the body, the knee, and extending inferiorly to the ankle, the **tibia** (shin bone) is the primary weight bearing structure of the lower leg and second longest bone in the entire body. It articulates with the decidedly smaller, non-weight bearing bone called the **fibula** at two **tibiofibular joints**, one proximal and one distal.



The proximal end of the tibia articulates with the femur and fibula. Like the femur they articulate with, the proximal end of the tibia expands to flattened **medial** and **lateral condyles** topped by **medial** and **lateral articular facets**. The space between the condyles, the **intercondylar eminence**, is the site of attachment for supporting ligaments of the knee. Anteriorly, the proximal tibia features an oval protuberance called the **tibial tuberosity**, where the patellar ligament inserts. This “bump” can be palpated through the skin immediately below the knee joint. The portion of the leg often referred to as the “shin” is the **anterior crest** of the tibial **shaft**, felt just below the skin continuing down to the ankle. Moving from the tibial tuberosity inferiorly, the shaft of the tibia narrows significantly. At its distal end, the tibia widens slightly to form articular structures at the ankle. The tibia forms a prominent bony projection on the medial aspect of the ankle aptly named the **medial malleolus**. Both the distal surface of the tibia and inner surface of its medial malleolus form part of the ankle joint with a tarsal bone. Laterally, the distal tibia articulates with the distal fibula in an indentation called the **fibular notch** which forms the distal tibiofibular joint.

Located along the lateral side of the lower leg, the fibula is not a weight-bearing structure but rather serves as a point of muscular attachments and provides stability to the lower leg. The proximal articulating end is called the **head** followed by a thin **shaft**. The distal end forms the **lateral malleolus**, felt as a bony protuberance on the lateral aspect of the ankle.

Activity 5.8.1: Identify and label the specific leg bones and their surface markings.



### Activity 5.8.2: Identify R vs. L and the anterior/posterior surface of the fibula and tibia.

#### Tibia (R & L)

Lateral condyle  
Medial condyle  
(Tibial plateau)  
Tibial tuberosity  
Anterior crest  
Medial malleolus

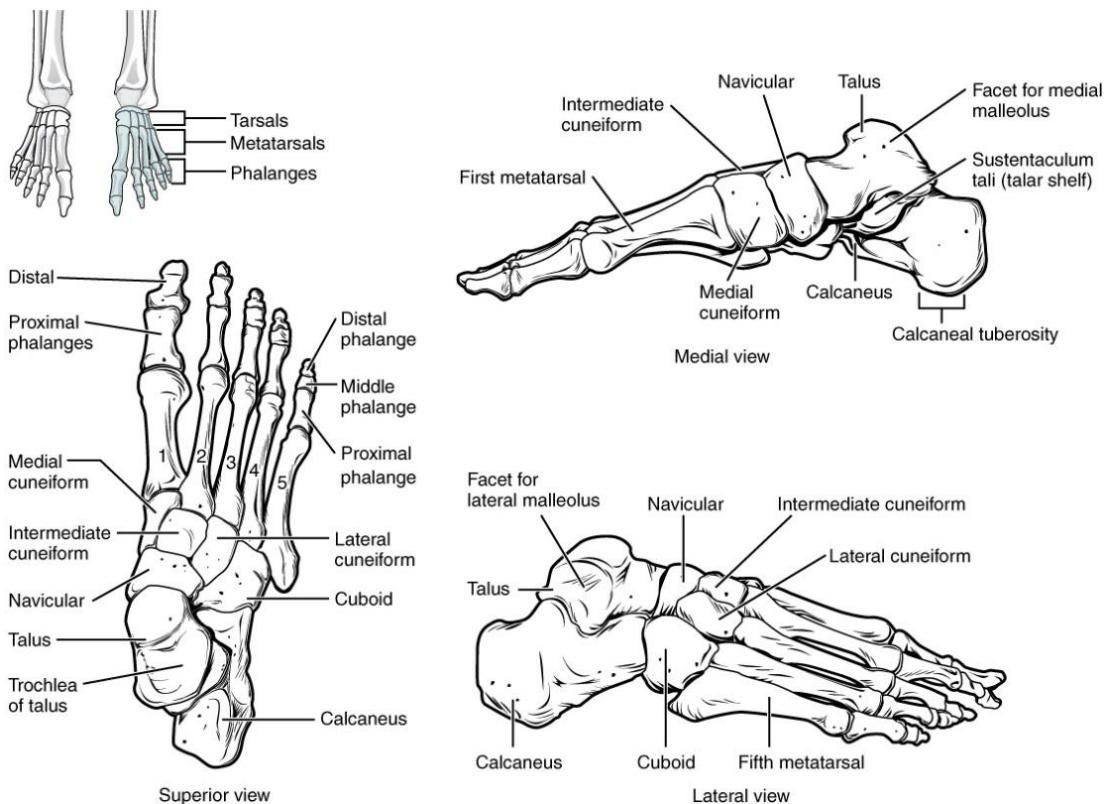
#### Fibula (R & L)

Head  
Lateral malleolus  
Interosseus membrane

Which bones do the tibia and fibula articulate with proximally? Distally?

## 5.9: Bones of the Ankle and Foot

The foot is formed by a combination of seven tarsal bones, five metatarsals, and 14 phalangeal bones. The tarsal bone responsible for forming the distal portion of the ankle joint is the **talus**. The talus is the most superior tarsal bone and has three articular surfaces interacting with the tibia and fibula. The inferior aspect of the talus articulates with the largest tarsal bone, the **calcaneus** (heel bone). The calcaneus is ultimately the bone responsible for supporting the weight of the entire body. Articulating anteriorly with the calcaneus and talus are the **cuboid** and **navicular** bones, respectively. Anterior to the navicular are **three cuneiform bones (medial, intermediate, and lateral)**. The superior aspect of these bones is noticeably wider than their inferior surfaces, lending themselves to the shape of the foot arch (transverse curvature).



Activity 5.9.1: Come up with your own mnemonic for remembering the order of the tarsal bones and write it in the space provided below.

### Activity 5.9.1: Identify and label the specific bones and their surface markings.

<b>Talus (left and right)</b>	<b>Second Cuneiform (left and right)</b>
<b>Calcaneus (left and right)</b>	<b>Third Cuneiform (left and right)</b>
<b>Navicular (left and right)</b>	<b>Cuboid (left and right)</b>
<b>First Cuneiform (left and right)</b>	

What is the joint between tarsal bones called?

List the ankle bones which articulate with the distal end of the tibia and fibula.

Connecting the tarsals to the toes (phalanges) are the **five metatarsal bones (I-V)**. Just like the metacarpals of the hand they are numbered 1-5; however, they are ordered from medial to lateral (big toe to little toe). The proximal end of each metacarpal is known as the **base** and its distal end is the **head**. It is the metatarsal heads which form the ball of the foot.

<b>Base</b>
<b>Shaft</b>
<b>Head</b>

What is the name of the joint between the distal tarsal bones and the metatarsals?

How are metatarsals most commonly fractured?

Articulating with the metatarsals are the **phalanges**. Just as with the phalanges of the hand, the toes are formed by 14 different phalangeal bones. The big toe or **hallux** is made from two bones, a proximal and distal phalange. Toes 2-4 are formed by three phalangeal bones each, a proximal, middle, and distal.

How many phalanges make up each foot?

Name the joint between the meta tarsals and the digits?

## 5.10: Synovial Joints of the Skeleton

Synovial joints are freely movable joints which in conjunction with bones and skeletal muscle allow for limb, head and torso movements. These joints are characterized by having a synovial cavity filled with a viscous lubricating fluid between articulating bones and is enclosed within a two-layered articular capsule. Specific terminology is used to designate the various movements that occur at synovial joints.

Activity 5.10.1: Identify synovial joint movements. Your instructor will provide you with images of various movements to complete the activity below

Image	Describe Movement	Name Joint
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		
K		
L		

## Structures to Know: Appendicular Skeleton

Complete the missing information for each table. These are the bones and markings you will be expected to identify.

Upper Limb		
Bones	Features to identify	Associated Joints
Clavicle (L&R)	Sternal end Acromial end	
(L&R)	Medial border Lateral border Spine of scapula Acromion Coracoid process Glenoid cavity Subscapular fossa	
(L&R)	Head Anatomical neck Intertubercular sulcus Greater tubercle Deltoid tuberosity Medial epicondyle Lateral epicondyle Trochlea Capitulum Olecranon fossa	
(L&R)	Olecranon Trochlear notch Coronoid process Radial notch Head Ulnar styloid process	
(L&R)	Head Radial tuberosity Radial styloid process	
Carpals	Right hand vs. Left hand	
	I-V	
Phalanges of Hand	Proximal, Middle, Distal	

Lower Limb			
Bones		Features to identify	Associated Joints
Os coxa (R&L)		Iliac Crest Anterior superior iliac spine Posterior inferior iliac spine Greater sciatic notch	
		Lesser sciatic notch Obturator foramen Ischial tuberosity	
		Inferior ramus	
(R&L)		Head Neck Greater trochanter Lesser trochanter Linea aspera Medial condyle Medial epicondyle Lateral condyle Lateral epicondyle Intercondylar fossa	
Patella (R&L)		Anterior vs. Posterior	
(R&L)		Tibial plateau Medial condyle Lateral condyle Tibial tuberosity Anterior crest Medial malleolus	
(R&L)		Head Lateral malleolus	
Tarsals		Right vs. Left Foot	
		I-V	
Phalanges of Feet		Proximal, Middle, Distal	

Upper Limb			
Joint	Associated Bones/Structures	# in Body	Movements Possible
Acromioclavicular			
Glenohumeral			
Humero-ulnar			
Humeroradial			
Proximal radio-ulnar			
Distal radio-ulnar			
Radiocarpal			
Carpometacarpal			
Interphalangeal			

## Spine & Lower Limb Joints

Joint	Associated Bones/Structures	# in Body	Movements Possible
Atlanto-occipital			
Atlanto-axial			
Intervertebral			
Sacroiliac			
Pubic symphysis			
Hip			
Patellofemoral			
Tibiofemoral			
Tibiofibular			
Ankle			
Subtalar			
Midtarsal			
Interphalangeal			