

# 1

# Skeletal System

## LEARNING OBJECTIVES

*Upon completion of this chapter, the student should be able to:*

- Locate and identify the bones (and their features) of the axial skeleton
- Locate and identify the bones (and their features) of the appendicular skeleton
- Identify important internal and external features of the skull, including: surface features, sutures, foramina, sinuses, bones of the orbit, and fontanelles (in the fetal skull)
- Identify the primary and secondary curvatures of the spine and describe the vertebrae that contribute to the distinct regions of the spinal column
- Identify the regions of the sternum and distinguish between the different classifications of ribs
- Locate the bones of the pectoral girdle and upper extremity and identify their major surface markings
- Locate the bones of the pelvic girdle and lower extremity and identify their major surface markings
- Describe some differences between the female and male bony pelvis
- Be familiar with some of the more common pathological conditions of the skeletal system

## SKELETAL SYSTEM OVERVIEW

The **skeletal system** is made up of 206 bones, cartilages, and ligamentous tissues that serve to provide support to the body and protect internal soft organs as well as provide attachments for skeletal muscles that are used to move the body. Additionally, the skeleton serves as a storage site for lipids and minerals such as calcium and phosphorus and as the site for hematopoiesis (blood cell production).

The skeleton is divided into two primary divisions: the **axial skeleton** (including the skull, vertebral column, and rib cage) and the **appendicular skeleton** (including the shoulder and pelvic girdles as well as the upper and lower extremities). Upon examination of the skeleton, it will be noticed that the bones are not smooth, but rather, they have various bumps, ridges, and openings that serve as sites of muscle attachment, articulations with other bones, and as passageways for blood vessels and nerves. Common names for bony projections that serve as attachment sites for tendons and ligaments include **tubercles, tuberosities, trochanters, crests, lines, spines, and rami (ramus)**. Common names for projections that help form articulations include **heads, processes, facets, and condyles**. Common names for openings or spaces in bones include **fissures, grooves, foramina (foramen), fossas, meatuses, and sinuses**. Familiarity with these terms will come in handy when identifying common features of the human skeleton in the laboratory setting.

## SKULL OVERVIEW

The skull is composed of **8 cranial bones** that make up the **cranium** that encases and protects the brain and **14 facial bones** that serve as the basis for attachment for the muscles of facial expression. The cranial bones include the paired **parietal** and **temporal** bones as well as the single **frontal, occipital, sphenoid, and ethmoid** bones. The facial bones include the paired **maxilla, zygomatic, palatine, nasal, lacrimal, and inferior nasal conchae** in addition to the singular **mandible** and **vomer** bones.

For a unique interactive experience, click on the **3D Anatomy** icon and then select **3D Skull**.

### 3D Skull

From there you are able to manipulate a three-dimensional skull by rotating it, moving it, zooming in and out, and even experience cutaway views.



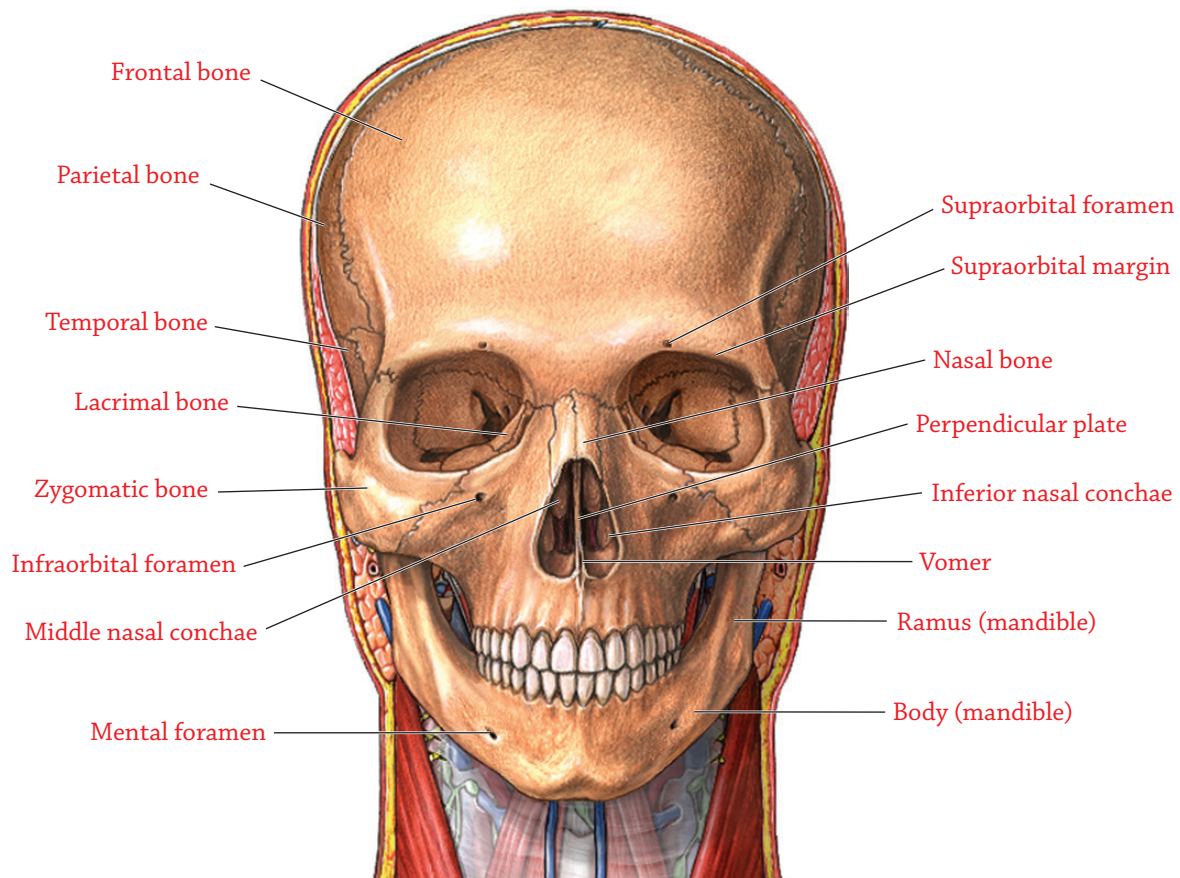
#### LAB ACTIVITY 1.1

##### Anterior View of the Skull

From this view of the skull, the **zygomatic**, **temporal**, **nasal**, **lacrimal**, **inferior nasal conchae**, and **parietal** bones are evident. The **frontal** bone with the **supraorbital margin** and **supraorbital foramen** (notch in some individuals) makes up the superior border of the orbit. In all, seven bones of the skull contribute to the orbit. To view a close-up of the orbit in its entirety, click on **AA Walls of Orbit (Ant)**. The **perpendicular plate** and **middle nasal conchae** of the **ethmoid** bone can be seen within the nasal cavity. The **vomer** (along with the perpendicular plate of the ethmoid bone) comprises the **nasal septum**. To view the nasal septum in its entirety, click on **DA ♂ A49** or **DA ♀ A49** as well as **DA ♂ L209** or **DA ♀ L210**. The **maxilla** (upper jaw) with the **infraorbital foramen** and the **ramus** and **body** of the **mandible** (lower jaw) with the **mental foramina** are easily seen from the anterior.

Identify and label the bones of the skull and their common markings visible from the anterior view in the following figure.

**DA ♂ A48** or **DA ♀ A47**





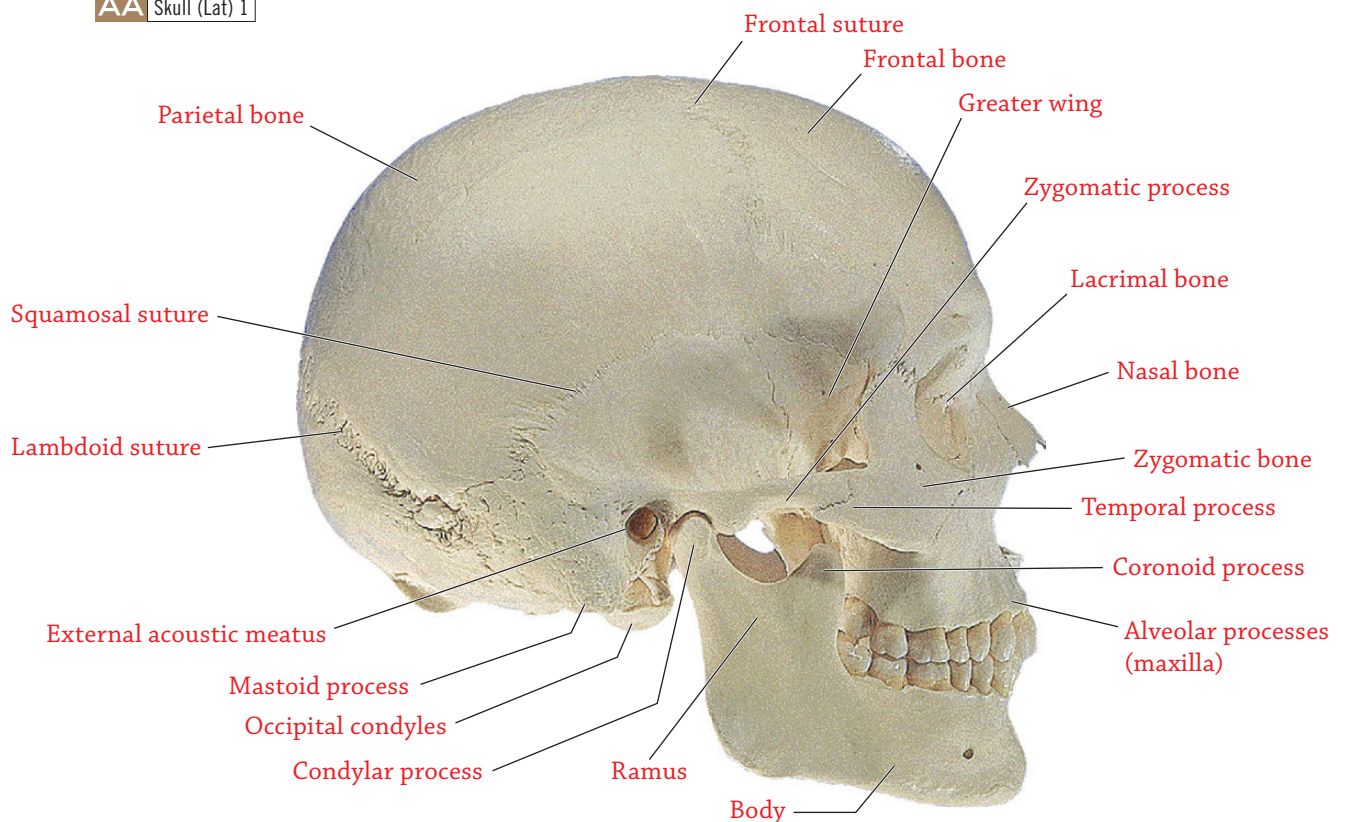
## LAB ACTIVITY 1.2

**Lateral View of the Skull**

From the lateral view of the skull, the **frontal**, **parietal**, **nasal**, and **lacrimal** bones may be seen. At the anterior aspect of this view, the **alveolar processes** of the **maxilla** are seen, while at the inferior aspect the **occipital condyles** may be visualized. The **greater wing** of the **sphenoid** bone can be seen articulating with the **squamous** part of the **temporal** bone. The temporal bone has several visible features in this view. The **mastoid process** may be found just inferior and posterior to the **external acoustic meatus**. The **zygomatic arch** is made from the union of the **zygomatic process** of the temporal bone and the **temporal process** of the **zygomatic** bone. The **body**, **ramus**, and **angle** of the **mandible** along with the **condylar process** (contributing to the **temporal mandibular joint**) and **coronoid process** may be visualized. Finally, three sutures are visible from the lateral aspect of the skull. The **frontal suture** is made from the union of the frontal bone and parietal bones; the **squamosal suture** is between the parietal and temporal bones; and the **lambdoid suture** is the connection between the occipital bones and the two parietal bones.

*Identify and label the bones of the skull and their common markings visible from the lateral view in the following figure.*

AA Skull (Lat) 1



To view comparable landmarks of the lateral skull, go to **DA** ♂ **L118** or **DA** ♀ **L118**. The **hyoid bone** is not considered a bone of the skull but will be included here since it is visible in this view. The hyoid bone is the only bone in the human skeleton that does not articulate with another bone. It serves as a point of attachment for several muscles of the tongue and larynx.



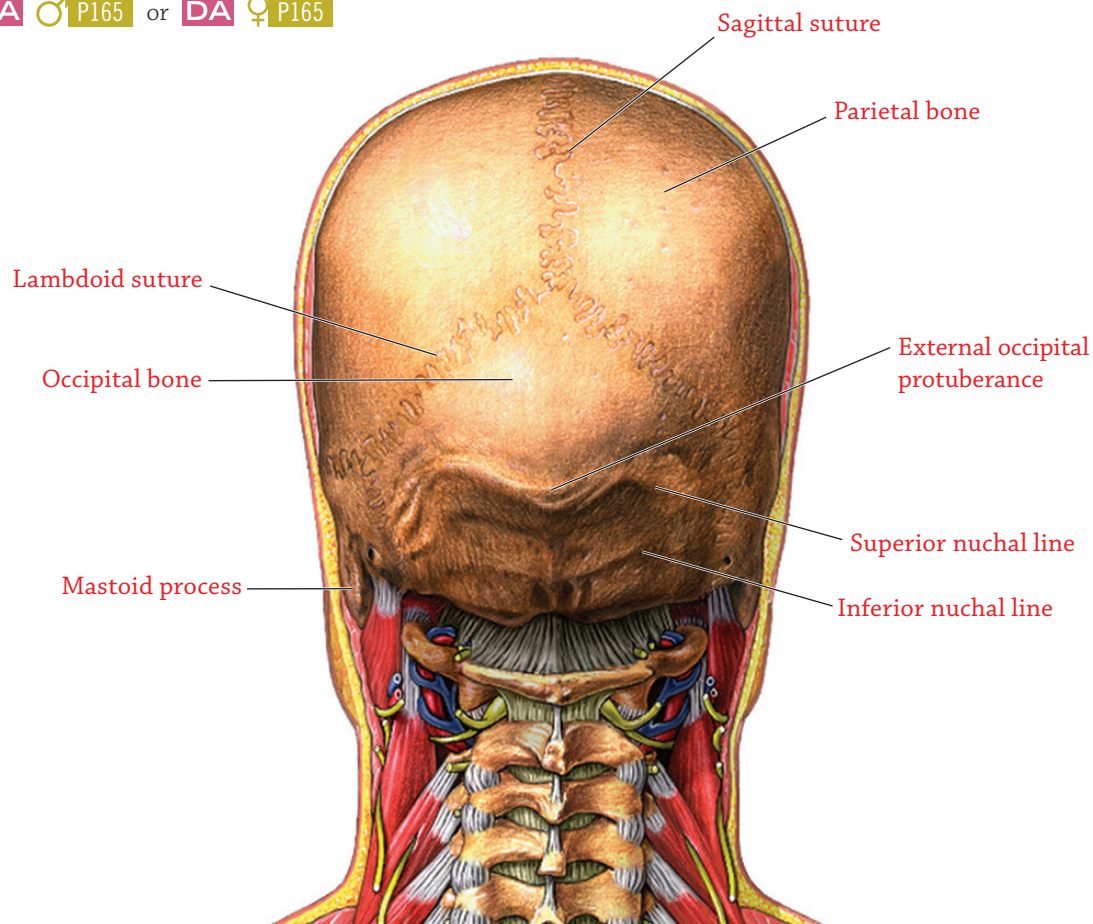
## LAB ACTIVITY 1.3

**Posterior View of the Skull**

The posterior view of the skull has but a few key landmarks worth noting. The **sagittal suture** is seen joining the left and right **parietal** bones. The **lambdoid suture** between the **occipital** bone and **parietal** bones may be seen also. Other features of the occipital bone include the **external occipital protuberance** (EOP, inion) and the **superior** and **inferior nuchal lines**. The **mastoid process** of the **temporal** bone can also be seen from the posterior view.

*Identify and label the bones of the skull and their common markings visible from the posterior view in the following figure.*

DA ♂ P165 or DA ♀ P165







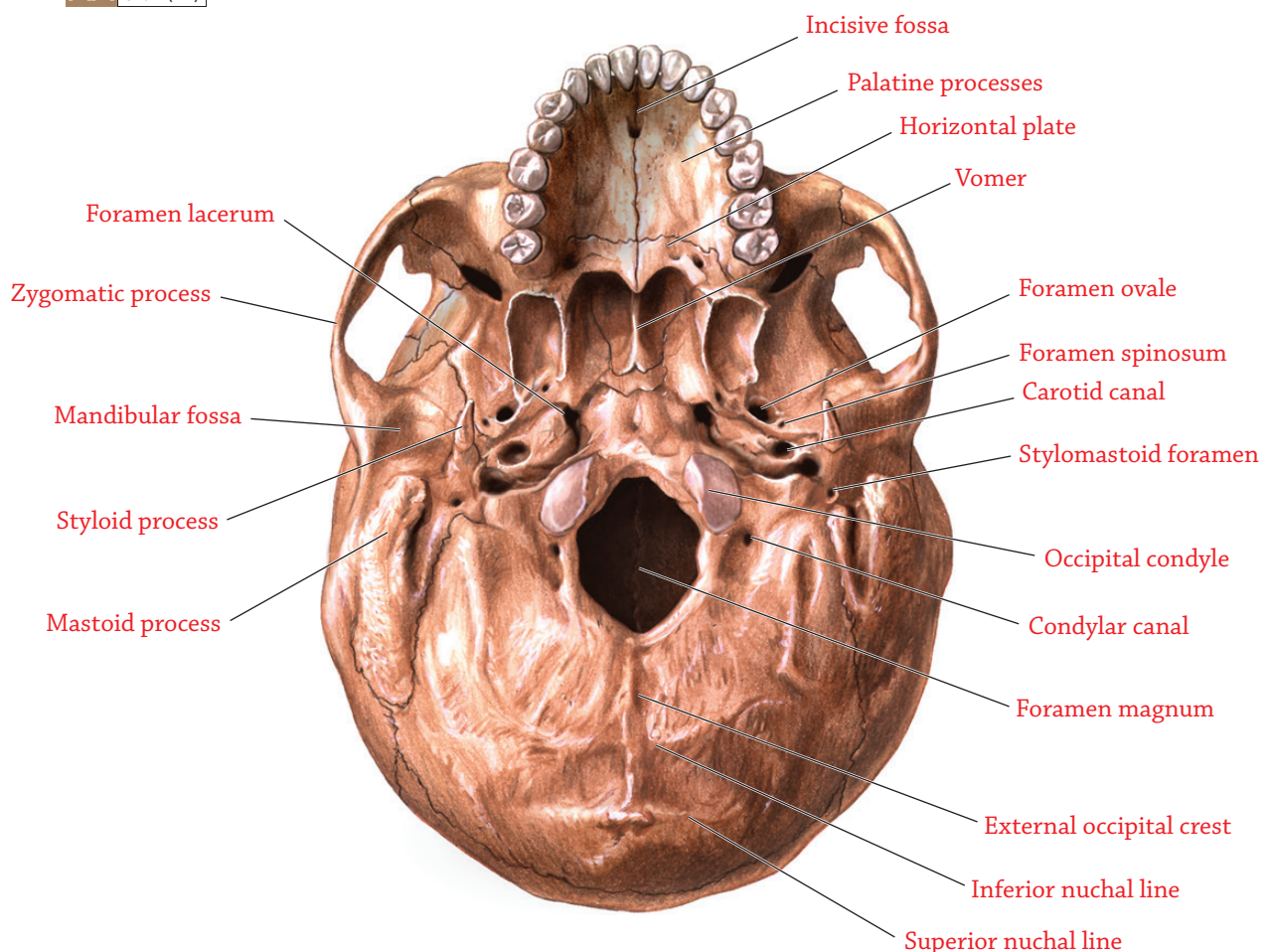
## LAB ACTIVITY 1.4

**Inferior View of the Skull**

The inferior aspect of the skull can be very intimidating with the abundance of projections, depressions, and openings, but with some practice (and patience), the following bones and markings may be identified. The **hard palate** is seen as the two **palatine processes** of the maxillae join with the two **horizontal plates** of the palatine bones. The rather large **incisive fossa** may be found at the most anterior aspect. Posterior to the palatine bones and in the midline is the **vomer**. Several foramina may be visualized in the **sphenoid** bone for the passing of cranial nerves. They include the **foramen ovale** and **foramen spinosum** in addition to the **foramen lacerum** that shares a border with the temporal bone. Other openings in the temporal bone include the **carotid canal** and the **stylomastoid foramen** that is nestled between the **mastoid process** and **styloid process**. The **mandibular fossa** receives the **head (condylar process)** of the mandible to form the temporomandibular joint (TMJ). Anterolateral to the mandibular fossa, the **zygomatic process** may be seen from below. The largest opening in the base of the skull is the **foramen magnum** of the occipital bone, located medially to the paired **occipital condyles**. The **condylar canals** may be found just posterior to the condyles. Finally, the **external occipital crest** is visualized from this angle along with the **superior** and **inferior nuchal lines**.

*Identify and label the bones of the skull and their common markings visible from the inferior view in the following figure.*

AA Skull (Inf)





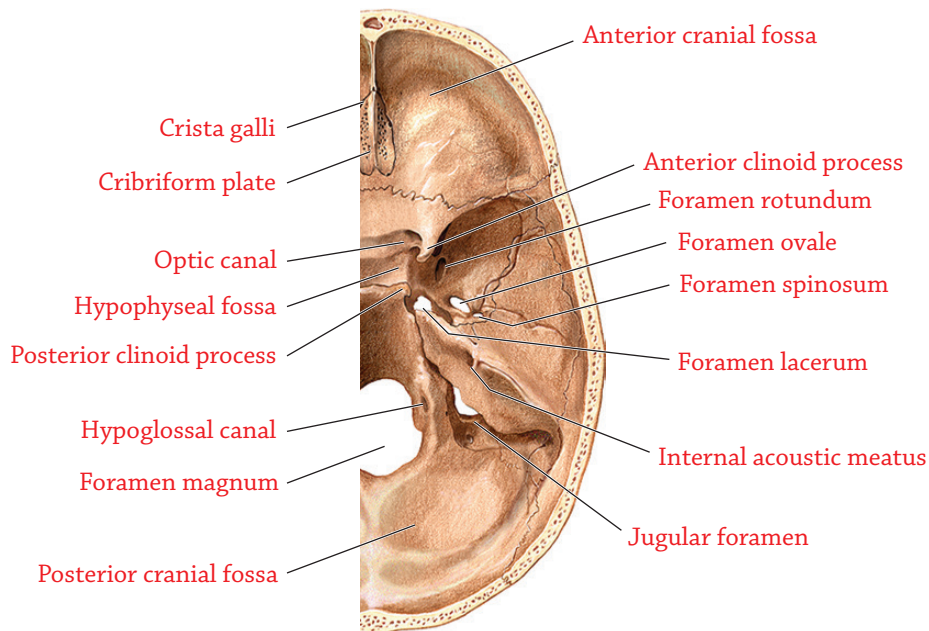
## LAB ACTIVITY 1.5

### Internal View of the Cranial Cavities

While viewing the interior aspect of the skull floor, three distinct regions may be visualized. The **anterior cranial fossa** encompasses the frontal and ethmoid bones; the **middle cranial fossa** is found between the lesser wings of the sphenoid bone and the petrous portion of the temporal bone; and the **posterior cranial fossa** sets upon the occipital bone. In the anterior cranial fossa, two features of the ethmoid bone are visualized. The raised **crista galli** serves as an attachment point for the dura mater, while the hole-riddled **cribriform plate** allows for olfactory nerve fibers to pass from the nasal mucosa to the brain. To view the olfactory nerve's relationship to the ethmoid bone, click on **AA** Olfactory Nerve in Nasal Cavity. The **sella turcica** of the sphenoid bone may be seen in the midline of the skull floor, situated between the **anterior** and **posterior clinoid processes**. The **hypophyseal fossa** is the depression within the sella turcica where the pituitary gland (hypophysis cerebri) is housed. Several openings in the skull floor can be visualized from the internal view. From anterior to posterior within the sphenoid bone are the **optic canal**, **superior orbital fissure**, **foramen rotundum**, **foramen ovale**, and the **foramen spinosum**. The large **foramen magnum** and smaller, paired **hypoglossal canals** may be seen within the occipital bone. Finally, within the temporal bone is found the **internal acoustic meatus**, while two other openings, the **foramen lacerum** and the **jugular foramen**, may be seen at its border.

Identify and label the bones of the skull and their common markings visible from the internal view in the following figure.

**AA** Cranial Cavities (Sup) 2



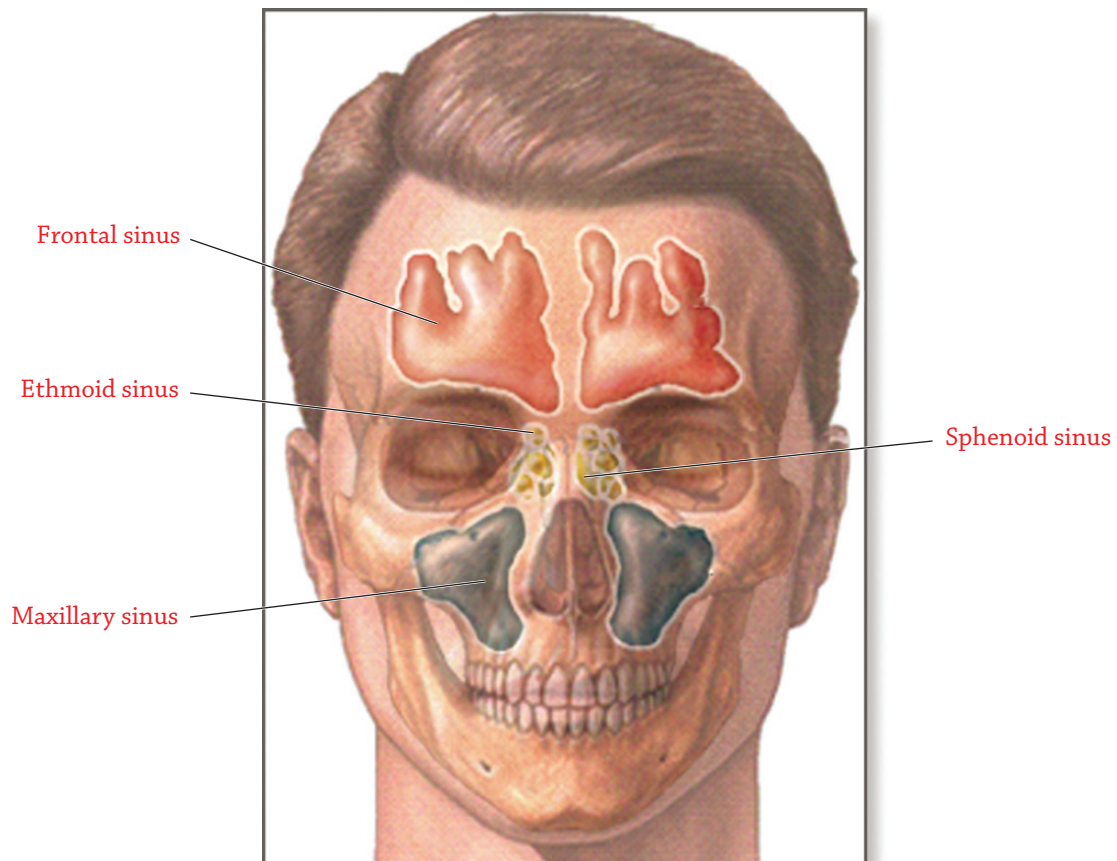


## LAB ACTIVITY 1.6

**Paranasal Sinuses**

Paranasal sinuses are mucosa-lined cavities within the skull that serve to lighten the skull, warm and humidify inspired air, and serve as resonance chambers for speech. The four skull bones that house the paranasal sinuses are the **frontal**, **maxillary**, **ethmoid**, and **sphenoid** bones.

*Identify and label the bones of the skull that house paranasal sinuses in the following figure.*

**CI** Sinuses

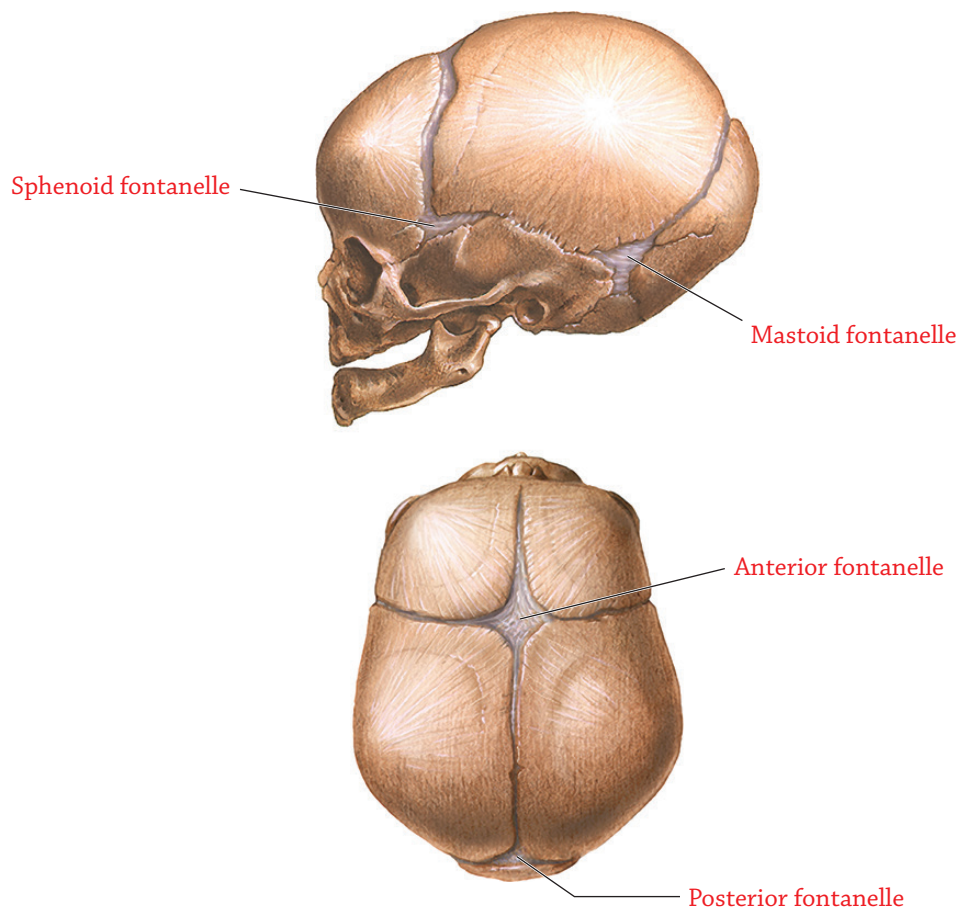


## LAB ACTIVITY 1.7

**The Fetal Skull**

As with the rest of the skeleton, the bones of the fetal skull are incompletely formed at birth. This nonunion of the skull bones allows the bones to shift (or mold) slightly to allow for easier passage through the birth canal. Click on **CI Fetal Head Molding** to visualize this process. Six distinct fontanelles, or “soft spots,” may be visualized at the junction of several cranial bones. The largest of these is the **anterior fontanelle** where the frontal (coronal) suture will eventually be found. Also in the midline can be found the **posterior fontanelle** where the lamboid suture will later be found. There are also two paired fontanelles—the **sphenoid (anterolateral)** and the **mastoid (posterolateral)** fontanelles. As the skull matures, the fontanelles should completely disappear by approximately 22 to 24 months of age.

*Identify and label the fontanelles in the fetal skull in the following figure.*

**CI** Skull of a newborn





## LAB ACTIVITY 1.8

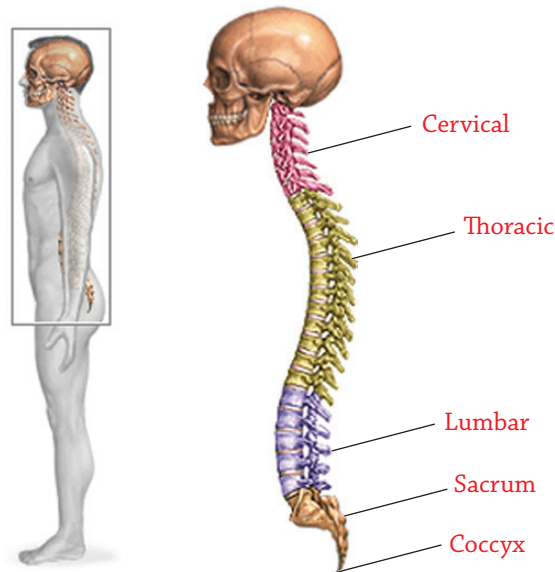
### The Vertebral Column

The vertebral (or spinal) column consists of 24 individual segments and 2 fused bones. There are **7 cervical**, **12 thoracic**, and **5 lumbar** vertebrae, all of which (except for C1/C2) are separated from each other by a fibrocartilage intervertebral disc (IVD). Five segments fuse together to give us a **sacrum**, while four segments fuse together to give us a **coccyx** (or tail bone). The **atlas (C1)** is unique in that it does not have a body but, instead, has an **anterior** and a **posterior arch**. The **axis (C2)** has a unique feature, the **dens** or **odontoid process**, which serves as a pivot point for the atlas to rotate (as in turning your head from side to side). All seven cervical vertebrae have a **transverse foramen** that allows for the passage of the vertebral artery. Each of the 12 thoracic vertebrae attaches to a corresponding rib and has **costal facets** (or demifacets) on the body for the attachment of the rib head and transverse costal facets for the attachment of the rib tubercle. The lumbar vertebrae are the thickest of all levels as they support the bulk of the axial stress of the body. The sacrum is unique in that the five segments of the fused sacrum are usually identifiable with the remnants of the IVDs seen as **transverse ridges**. The **anterior** and **posterior sacral foramina** allow for the exit of spinal nerves from the sacrum. Laterally are the wing-like **alae** that articulate with either side of the os coxae (pelvic bones) forming the **sacroiliac joints**. Posteriorly may be found the **median sacral crest** that is the remnant of the spinous processes of the sacral segments. The inferior aspect of the sacrum articulates with the **coccyx**, or tail bone.

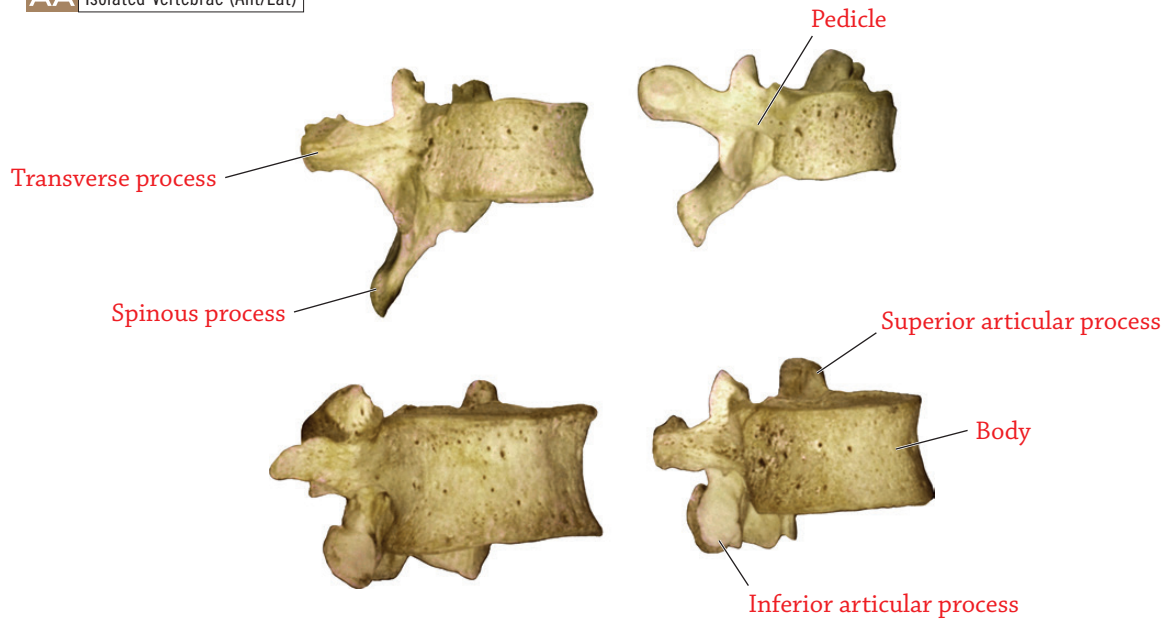
With the exception of C1 and C2, the other 22 vertebrae all have similar “typical” features. The **body** (centrum) is the thickest part of the vertebra that attaches to the IVD. Extending posteriorly from the body are the paired **pedicles**. Paired **transverse processes** project laterally while a single **spinous process** projects posteriorly. Between the transverse and spinous processes is where the **laminae** are found. The **vertebral** (or spinal) **foramen** is the large opening in the neural arch for the passage of the spinal cord. Projecting upward from the neural arch are paired **superior articulating processes** (with an articulating facet), while the **inferior articulating process** are found in the opposite direction (also with an articulating facet).

*Identify and label the spinal levels and typical features of the vertebrae in the following figures.*

#### CI Skeletal Spine



## AA Isolated Vertebrae (Ant/Lat)



## CLINICAL APPLICATIONS

The fetal spine is “C-shaped” in utero with a convex curvature to the posterior (kyphotic). Spinal curves that are kyphotic in nature are referred to as primary curves since they are present at birth. As the infant begins to crawl and lift the head, a secondary curve develops in the cervical spine (lordosis). Later, as the child moves from crawling to an upright posture, another secondary curvature develops in the lumbar spine. Three abnormal curvatures of the spine may develop as a result of trauma, degeneration, or abnormal muscle tone. A lateral curvature of the spine is known as scoliosis. A hyperkyphotic curvature of the thoracic spine is commonly known as a “hunchback,” whereas a hyperlordosis of the lumbar spine is referred to as a “swayback.”

To view some images of spinal curvatures in AIA:

1. Click on [Clinical Illustrations](#); Select **Skeletal**, **All**, **All**, **All**, and **All** from the drop-down menus.
2. Click “**Search**.”
3. Find the images titled **Spinal Curves**, **Scoliosis**, **Signs of Scoliosis**, **Osteoporosis of the Spine**, and **Lordosis** to view the variations in spinal curvatures.

**CI** Spinal Curves

**CI** Scoliosis

**CI** Signs of Scoliosis

**CI** Osteoporosis of the Spine

**CI** Lordosis

It is estimated that over 80% of the adult population will experience low back pain (LBP) at some point in their lives. Treatments for LBP may be as varied as the causes. While some treatments may be as simple as rest and stretching/strengthening exercises, other cases may require chiropractic, physical therapy, medication, or even surgery. Go to [Low Back Pain](#) to view an animation on LBP.

To view some images of intervertebral disc lesions in AIA:

1. Click on [Clinical Illustrations](#); Select “**Skeletal**,” “**All**,” “**All**,” “**All**,” and “**All**” from the drop-down menus.
2. Click “**Search**.”
3. Find the images titled **Herniated Lumbar Disc**, **Herniated Nucleus Pulposus**, **Spinal Stenosis**, **Laminectomy—L4**, and **Lumbar Discectomy**, to view some causes and surgical treatments for LBP.

**CI** Herniated Lumbar Disc

**CI** Herniated Nucleus Pulposus

**CI** Spinal Stenosis

**CI** Laminectomy—L4

**CI** Lumbar Discectomy



## LAB ACTIVITY 1.9

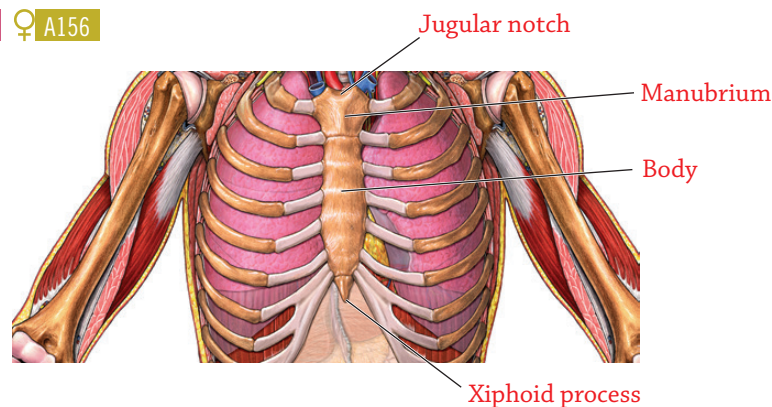
## The Sternum and Ribs

The **sternum**, or breastbone, is made from the union of three distinct bones. The most superior of these bones is the **manubrium**, with the **jugular notch** on its superior border. Laterally, the manubrium will articulate with the clavicle at the sternoclavicular joint. The largest section of the sternum is the **body** (gladiolus). The most inferior section is referred to as the **xiphoid process**.

Twelve pairs of ribs make up the thoracic cage. Ribs 1 to 7 are known as **true ribs** (vertebrosternal) and have individual cartilage attachments to the sternum. Ribs 8 to 12 are classified as **false ribs** and be further subdivided based on their articulations. Ribs 8 to 10 share a common cartilage attachment and are known as **vertebrochondral ribs**, whereas ribs 11 and 12 have no anterior attachment and are classified as **floating** or **vertebral ribs**. The **head, neck, tubercle, angle, and body** of the ribs may be seen by clicking on **AA 1st, 3rd, & 8th ribs**.

Identify and label the regions of the sternum as well as the ribs in the following figure.

DA ♂ A156 or DA ♀ A156



Try to compare as many features as you can identify from the illustration above to the Cadaver Photograph in the following image.

AA Dissection of Thorax (Ant)





## LAB ACTIVITY 1.10

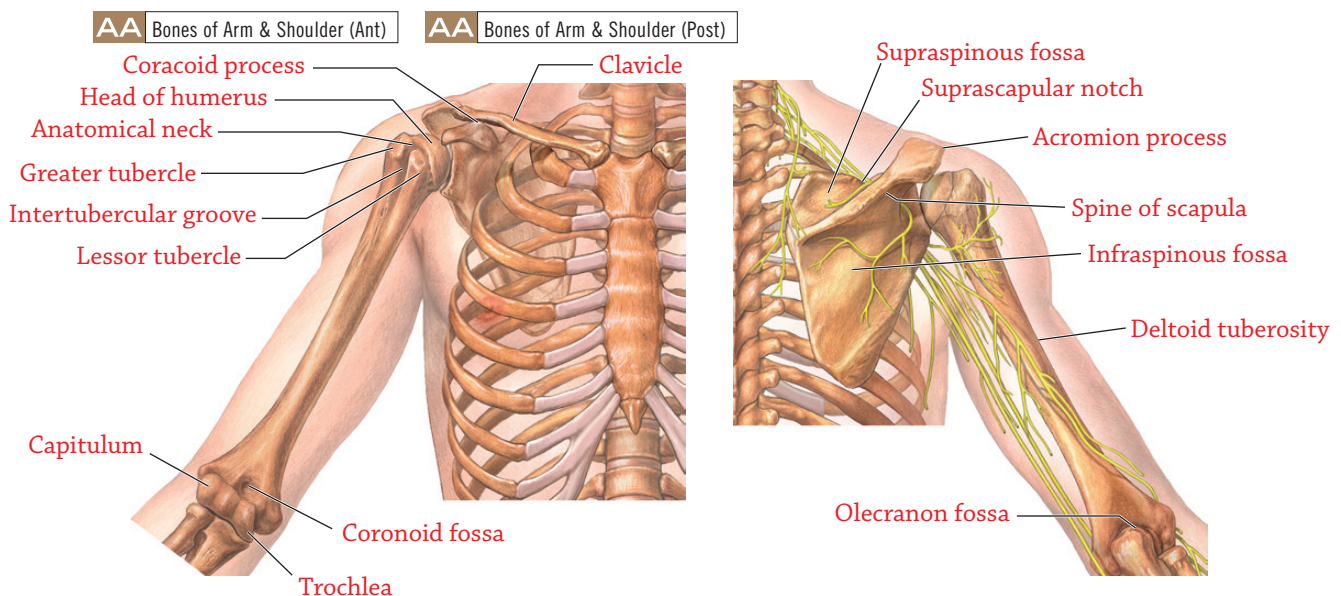
### The Pectoral (Shoulder) Girdle

The pectoral, or shoulder, girdle consists of two bones that connect the upper extremity to the axial skeleton—the **clavicle** (collarbone) and the **scapula** (shoulder blade). The **clavicle** is flat and S-shaped and articulates medially with the manubrium at the sternoclavicular joint and laterally with the scapula at the acromioclavicular joint. The **scapula** is a triangular-shaped bone with the lateral-most angle articulating with the humerus at the shallow **glenoid fossa**. The medial border faces the vertebral column whereas the lateral border faces the axilla (armpit). The **suprascapular notch** is visible along the superior border. The ventral aspect of the scapula rests against the rib cage and contains the **subscapular fossa**. A prominent ventral projection that serves as a muscular attachment is the **coracoid process**. The dorsal aspect of the scapula has a prominent ridge (**spine of the scapula**) that separates the **supraspinous fossa** from the **infraspinous fossa**. The spine of the scapula terminates laterally in a prominent projection called the **acromion process**, which articulates with the clavicle.

### The Arm

The **humerus** is the single bone of the arm. Proximally, there are three prominent projections. The large, rounded **head** articulates medially with the scapula. The **greater tubercle** can be found laterally, while the **lesser tubercle** is found slightly medial and inferior. Between the tubercles is the **intertubercular groove** that houses the tendon of the long head of the biceps brachii. The **anatomical neck** is found encircling the head, while the surgical neck, a common site of fracture, is found around the proximal metaphysis of the humerus. The **deltoid tuberosity** is a broad, roughened region on the lateral aspect of the shaft where the deltoid muscle has its insertion. Distally, the humeral condyles are known as the medial **trochlea** that articulates with the ulna and the lateral **capitulum** that articulates with the radius. Just proximally and wide to the condyles are the two **epicondyles**. The shallow **coronoid fossa** on the anterior surface and the deeper **olecranon fossa** posteriorly allow room for the corresponding ulnar processes during flexion and extension of the elbow joint.

Identify and label the bones of the pectoral girdle and arm, along with their features, in the following figures.







## LAB ACTIVITY 1.11

### The Forearm

The forearm is formed by two parallel bones—the **radius** laterally and the **ulna** medially. The **head** of the radius articulates proximally with the **capitulum** of the humerus. Just distal and medial to the head is the **radial tuberosity**, which serves as the insertion for the biceps brachii muscle. The **styloid process** may be seen as the most distal projection of the radius. The proximal ulna has the large **olecranon process** to the posterior and the smaller **coronoid process** to the anterior. The head of the ulna is at the distal end of the bone and has the small **styloid process** projecting of its medial aspect.

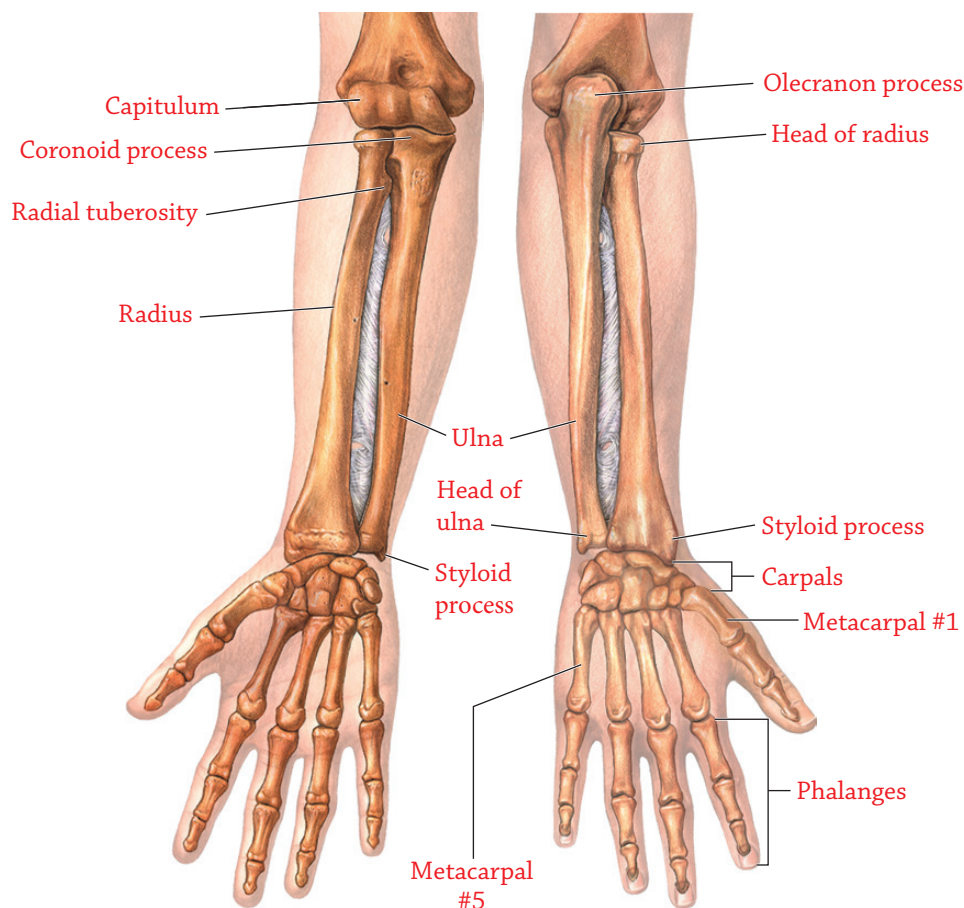
### The Hand

The hand is made up of 27 bones that are divided into three distinct groups: the carpals (wrist), metacarpals, and phalanges (fingers). The eight **carpals** are divided into a proximal row (from lateral to medial—scaphoid, lunate, triquetral, pisiform) and a distal row (from lateral to medial—trapezium, trapezoid, capitate, hamate). The five **metacarpals** are found within the palm of the hand and are numbered 1 to 5 beginning laterally with the thumb (**pollex**). Digits 2 to 5 have three **phalanges** each (proximal, middle, distal) while the thumb only has two (proximal and distal).

Identify and label the bones of forearm and hand, along with their features, in the following figures.

AA Bones of Forearm &amp; Hand (Ant)

AA Bones of Forearm &amp; Hand (Post)





## CLINICAL APPLICATIONS

*Arthritis* is a very general term that simply refers to the inflammation of a joint. Two of the most common forms of arthritis seen clinically are **osteoarthritis (OA)** and **rheumatoid arthritis (RA)**. Osteoarthritis is often referred to as the “*wear and tear*” form of arthritis and usually results from overuse, repetitive trauma, and aging. The symptoms of OA generally get worse over time but can be treated with conservative methods such as chiropractic and physical therapy to slow the progression of the disease as well as the use of some over-the-counter medications to help alleviate discomfort. OA is also known as **degenerative joint disease (DJD)**. X-ray changes may show bone wearing down at the ends of the bone, bone spur formation (osteophytes), and a decrease in joint space. Symptoms usually appear in middle age and include pain and stiffness in the joint with a limited range of motion. **Rheumatoid arthritis** is an autoimmune disease where the immune system of the individual attacks healthy joint tissues. RA can occur at any age but is more common in middle age and tends to affect women more than men. RA tends to affect the body bilaterally, with the most affected joints including the fingers, wrist, knees, feet, and ankles. Over time, joints may lose their range of motion and even become deformed. While OA symptoms are restricted to the joint, RA can affect other tissues as well such as the lungs, heart, and blood vessels. Treatment of RA usually includes medications to prevent inflammation and suppress immune function along with therapeutic treatment to reduce swelling and discomfort. Surgical correction is sometimes necessary to treat joint deformation and immobilization.

*To view some images of osteoarthritis and rheumatoid arthritis in AIA:*

1. Click on **Clinical Illustrations**; Select “**All**,” “**Skeletal**,” “**All**,” “**All**,” and “**Orthopedics**” from the associated drop-down menus.
2. Click “**Search**.”
3. Find the corresponding images.



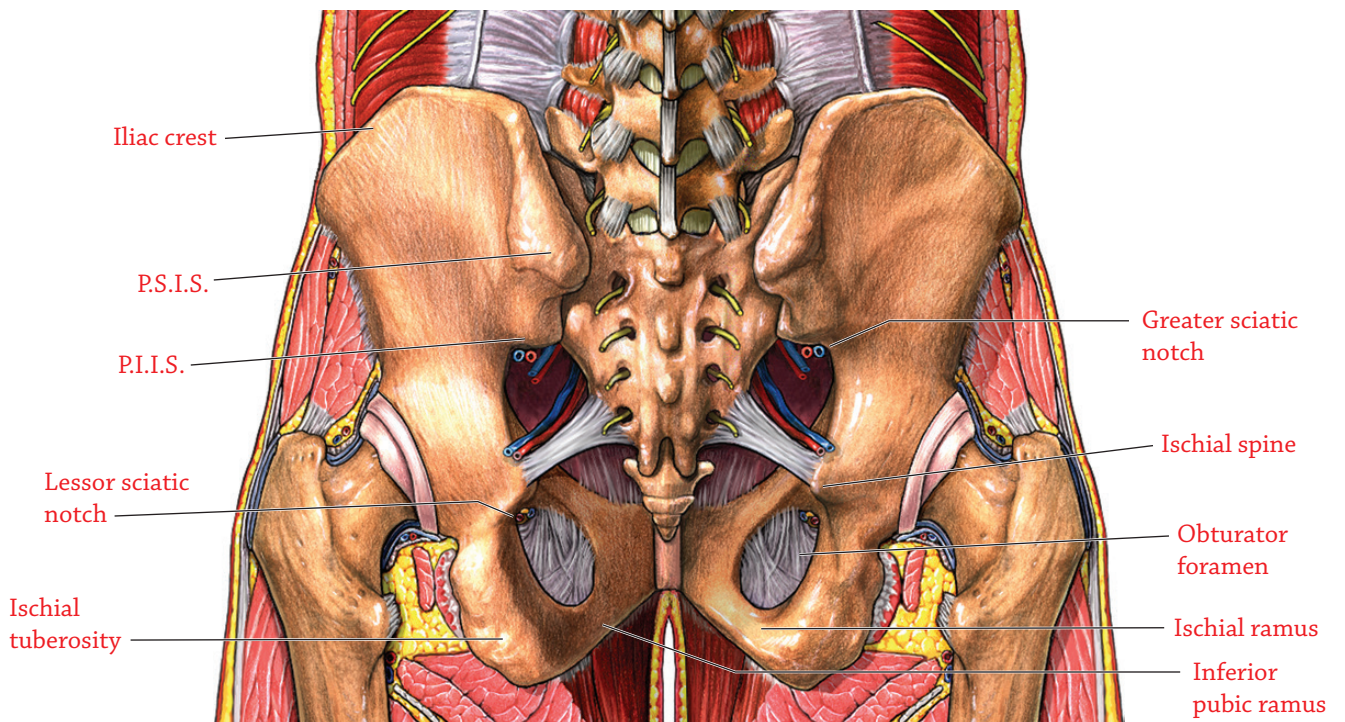
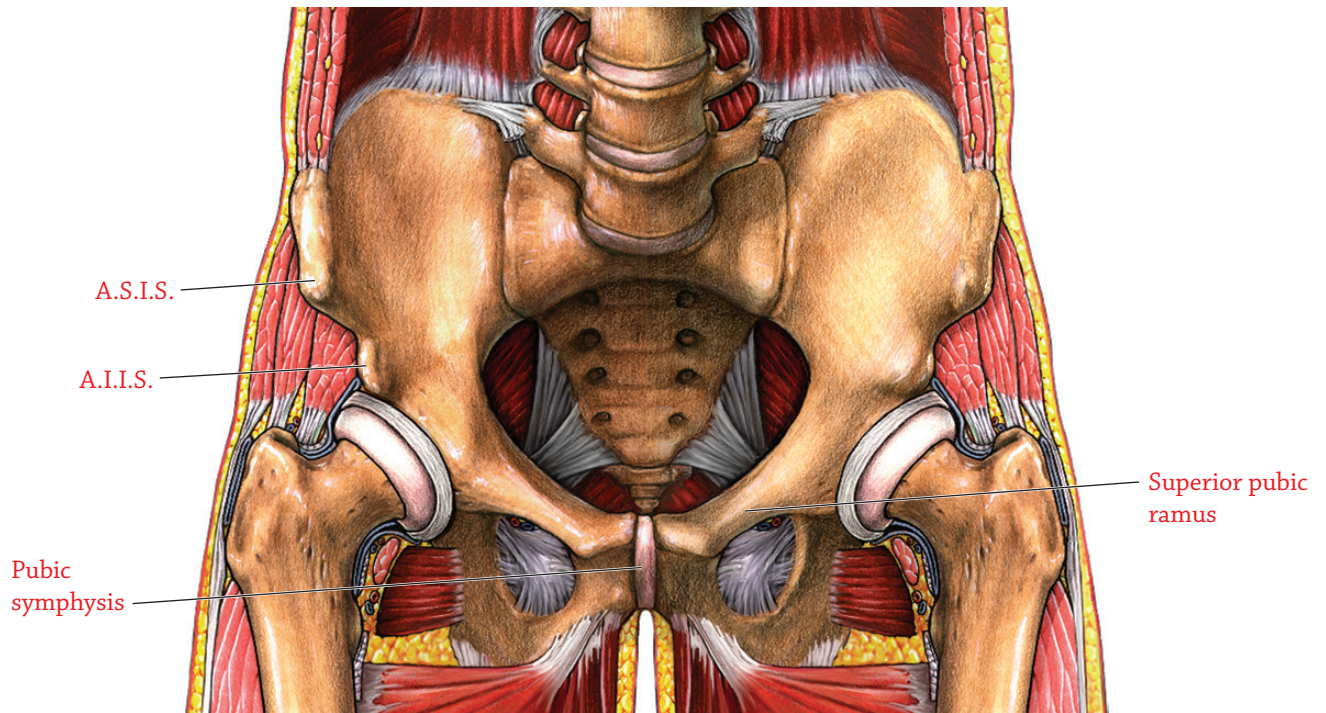
## LAB ACTIVITY 1.12

### The Pelvic Girdle

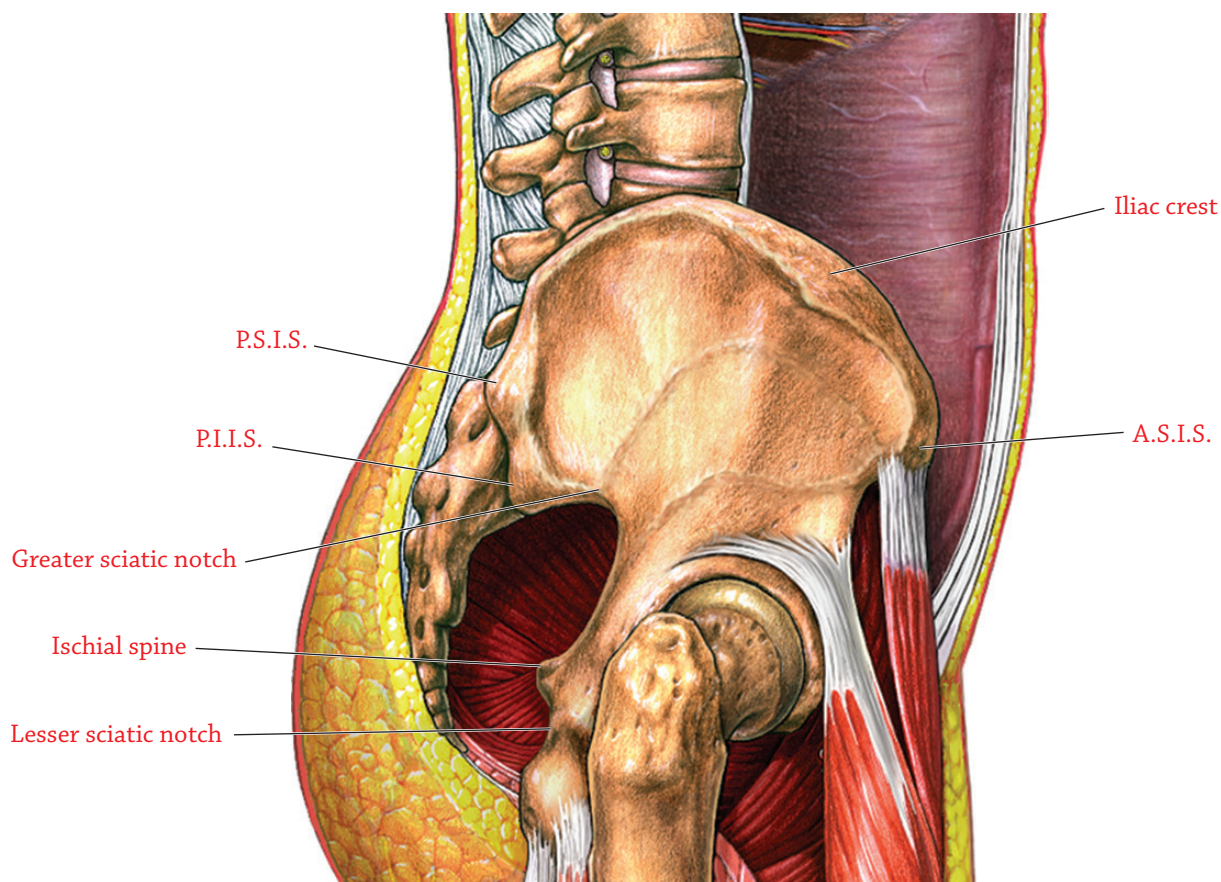
The pelvic girdle is formed by the two hip bones (ossa coxae or pelvic bones). Posteriorly, the pelvic bones are joined to the sacrum at the sacroiliac joint, and anteriorly, they connect at the fibrocartilage pubic symphysis. Each **os coxae** is actually formed by the union of three separate bones—the ilium, ischium, and pubis. The **ilium** has the iliac crest at the most superior aspect of the bone. Anteriorly, the **iliac crest** ends at the **anterior superior iliac spine**, while posteriorly it ends at the **posterior superior iliac spine**. Just below each superior iliac spine can be found a corresponding **inferior iliac spine**. The **ischium** is known as the “butt” bone, and the brunt of the body weight rests on the **ischial tuberosity** when in the seated position. The **ischial spine** projects posteriorly and separates the superior **greater sciatic notch** from the inferior **lesser sciatic notch**. The **ramus** of the ischium connects to the **inferior pubic ramus** anteriorly. Then, with the addition of the **superior pubic ramus**, the large **obturator foramen** is formed. The two pubic bones are joined anteriorly at the **pubic symphysis**. Laterally, the individual bones of the os coxae unite at the **acetabulum**, or hip socket, which receives the head of the femur to make the hip joint.

Identify and label the bones of pelvic girdle, along with their features, in the following figures.

DA	♂	A326	or	DA	♀	A326
DA	♂	P173	or	DA	♀	P173
DA	♂	L287	or	DA	♀	L287







## CLINICAL APPLICATIONS

Joint replacement surgeries are becoming increasingly popular as the numbers of the geriatric population continue to rise. Two of the most commonly replaced joints are the weight-bearing joints of the lower extremity, the hip joint and knee joint. You have probably heard someone say that they had fallen and broken their hip. In all likelihood, though, it was the opposite—they broke their hip, which caused them to fall. To make matters more confusing, it is not their “hip” that has broken at all but rather the neck of their femur. Osteoporosis, arthritis, injury, and even a history of certain medications are a few reasons that may lead to the need for a total joint replacement.

To view some images of knee and hip joint replacement surgeries in AIA:

1. Click on “[Clinical Illustrations](#)”; select “**Lower Limb**,” “**Skeletal**,” “**All**,” “**All**,” and “**Orthopedics**” from the associated drop-down menus.
2. Click “**Search**.”
3. Find the corresponding images.





## LAB ACTIVITY 1.13

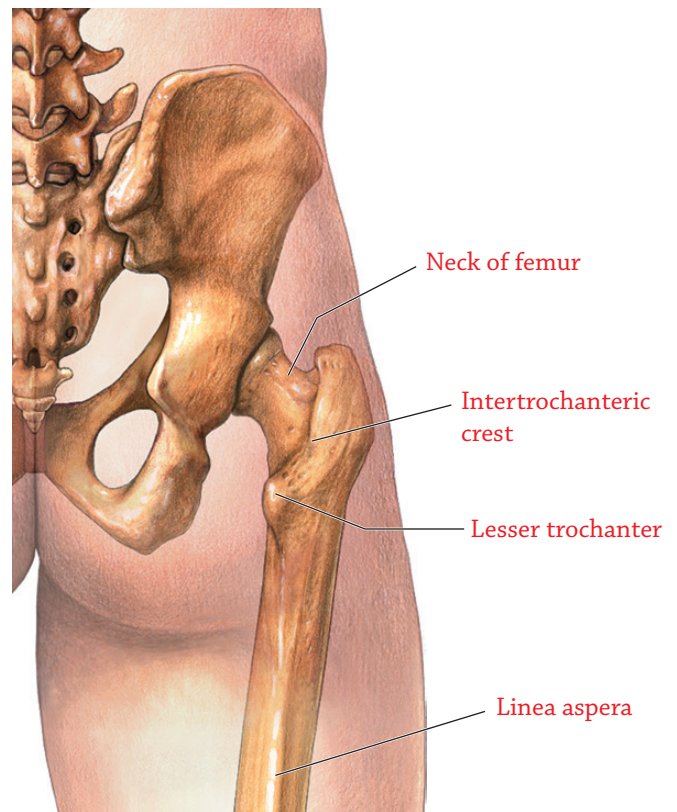
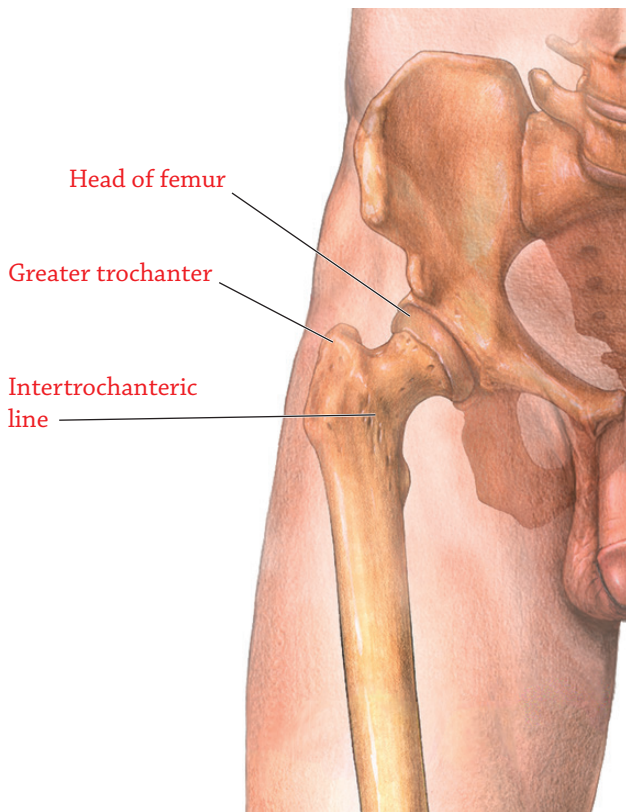
**The Thigh**

The **femur**, the largest and heaviest bone in the body, is the single bone of the thigh. Its **head** articulates proximally with the acetabulum as it forms a deep, stable ball-and-socket type joint. At the inferior aspect of the femoral **neck** may be found two trochanters. The larger, **greater trochanter** is found laterally while the smaller **lesser trochanter** is found medially and slightly inferior. The more prominent **intertrochanteric crest** connects the two posteriorly while the **intertrochanteric line** connects them anteriorly. The **linea aspera** is a raised ridge that runs down the posterior aspect of the femoral shaft and serves as an attachment point for several muscles of the thigh. The distal end of the femur articulates with the tibia at the **medial** and **lateral condyles**. The **patellar surface** is found between the condyles on the anterior aspect and serves as an articulation site for the patella (kneecap). The medial and lateral **epicondyles** are found just above their respective condyles. On the medial aspect of the distal femur is an additional projection, the **adductor tubercle**, an insertion point for the powerful adductor muscles of the thigh.

*Identify and label the features of the femur, along with the proximal and distal articulating bones, in the following figures.*

AA Bones of Lower Limb (Ant)

AA Bones of Lower Limb (Post)





## CLINICAL APPLICATIONS

Advances in surgical techniques have allowed for minimally invasive joint surgery, known as **arthroscopic surgery**, which generally allows patients to return home the same day the procedure is performed. With arthroscopic surgery, several buttonhole-sized incisions are made in the skin for the insertion of an **arthroscope** (instrument to view the joint space) and various arthroscopic surgical instruments. Arthroscopic examination not only allows the physician to make a more definitive diagnosis of joint injury and disease but it also allows for a prompt surgical correction when indicated.

To view some images of arthroscopy in AIA:

1. Click on **Clinical Illustrations**; Select “**All**,” “**Skeletal**,” “**All**,” “**All**,” and “**Orthopedics**” from the associated drop-down menus.
2. Click “**Search**.”
3. Find the corresponding images.



## LAB ACTIVITY 1.14

### The Leg

The leg is formed by two parallel bones—the larger, medial tibia (shin bone) and the thin, lateral fibula. The **tibia** is the weight-bearing bone of the leg and has the **medial** and **lateral condyles** proximally to articulate with the corresponding condyles of the femur at the knee joint. Between the tibial condyles is the raised **intercondylar eminence**. The **tibial tuberosity** is the prominent bump on the anterior aspect of the tibia that serves as the insertion point of the patellar ligament. Distally, the tibia articulates with the talus at the tibiotalar (ankle) joint. The rounded knob on the medial aspect is the **medial malleolus** while the **fibular notch** (on the lateral aspect) receives the **lateral malleolus** of the **fibula**. The proximal end of the fibula, the **head**, does not contribute to the knee joint but instead articulates with the lateral condyle of the tibia.



## CLINICAL APPLICATIONS

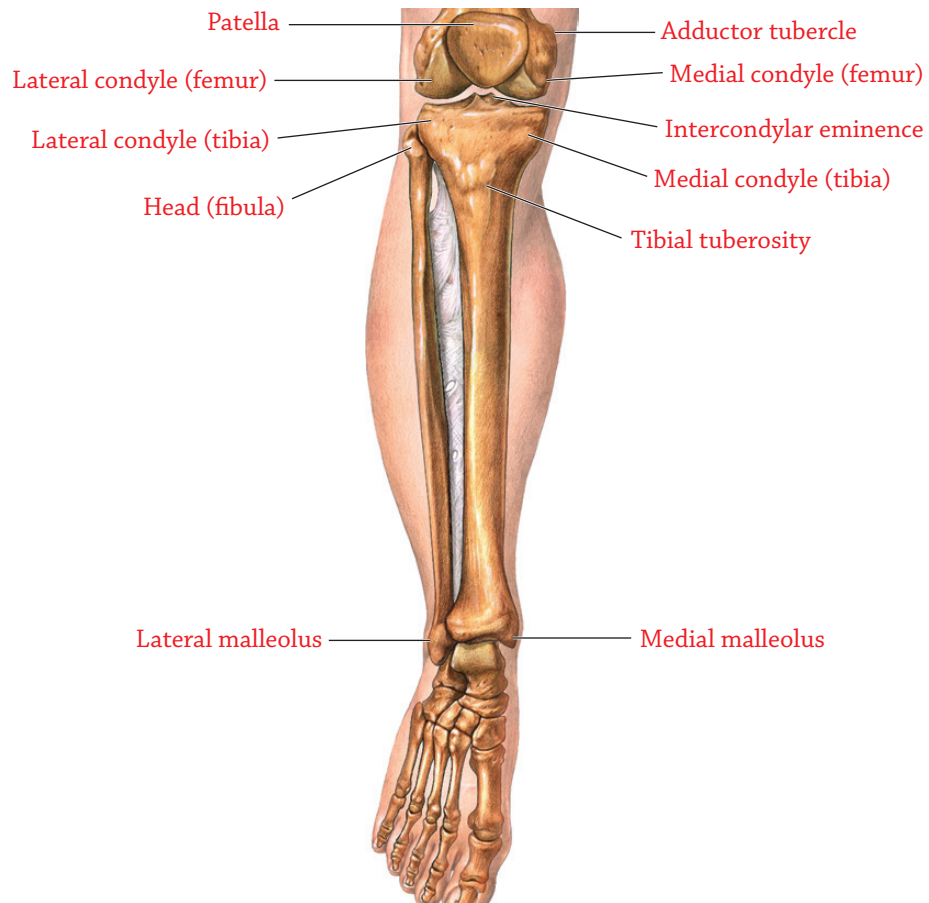
Irritation of the tibial tuberosity in adolescents causes a condition of pain and inflammation known as Osgood-Schlatter disease.

1. Click on **Clinical Illustrations**; Select “**Skeletal**,” “**All**,” “**All**,” “**All**,” and “**All**” from the drop-down menus.
2. Click “**Search**.”
3. Find the images titled **Leg Pain (Osgood-Schlatter)**.

**CI** Leg Pain (Osgood-Schlatter)

Identify and label the bones of the leg, along with their features, in the figure below.

**AA** Bones of Leg & Foot (Ant)





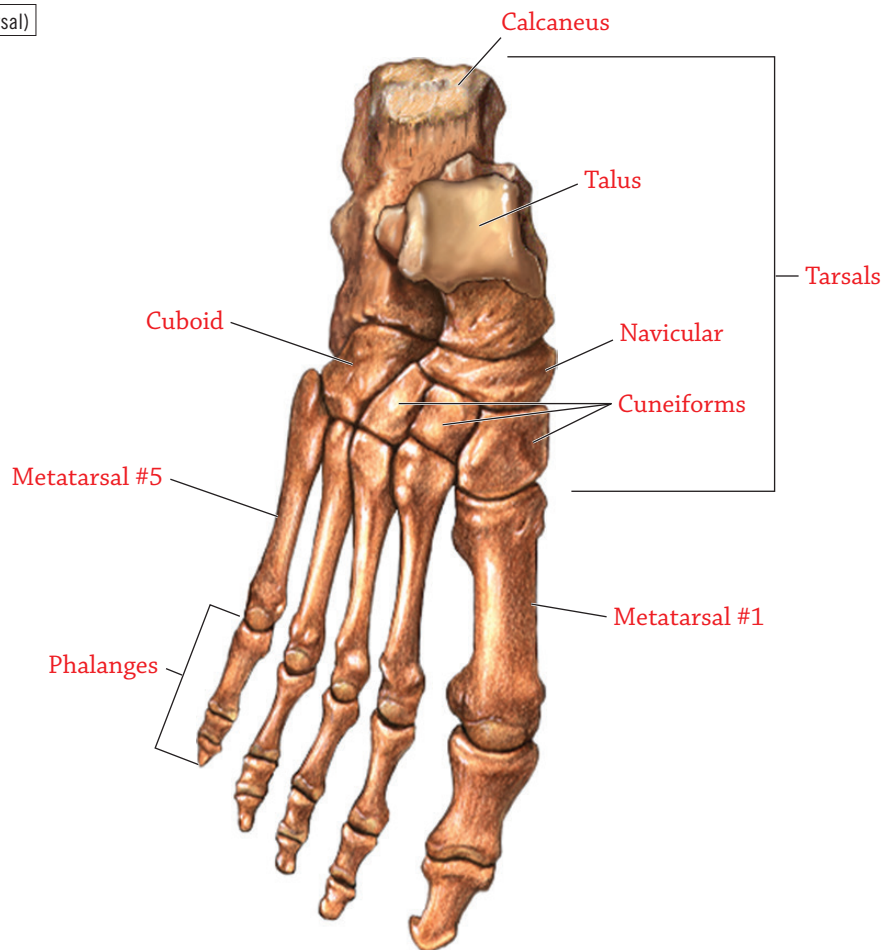
## LAB ACTIVITY 1.15

**The Foot**

The foot is made of up 26 bones that are divided into three distinct groups: the tarsals (ankle), metatarsals, and phalanges (toes). The seven **tarsals** of the ankle are the talus (articulates with the tibia), calcaneus (heel bone), navicular, the cuneiforms (medial, intermediate, lateral), and the cuboid. The five **metatarsals** form the sole of the foot and are numbered 1 to 5 beginning medially with the great toe (**hallux**). Digits 2 to 5 have three **phalanges** each (proximal, middle, distal) while the hallux only has two (proximal and distal).

*Identify and label the bones of foot and ankle in the following figure.*

AA Bones of Foot (Dorsal)







## SKELETAL SYSTEM REVIEW EXERCISES

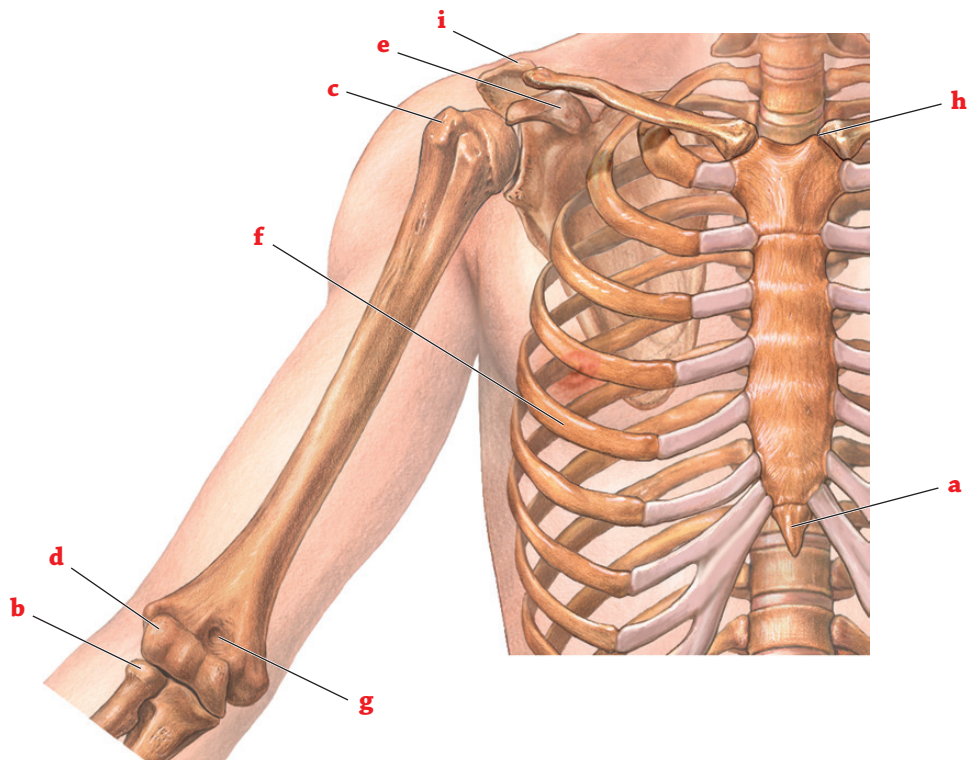
### Matching

- |                                       |                   |
|---------------------------------------|-------------------|
| <u>c</u> 1. Mastoid process           | a. frontal bone   |
| <u>e</u> 2. Cribriform plate          | b. sphenoid bone  |
| <u>f</u> 3. Infraorbital foramen      | c. temporal bone  |
| <u>h</u> 4. The “cheek bone”          | d. mandible       |
| <u>g</u> 5. Foramen magnum            | e. ethmoid bone   |
| <u>d</u> 6. Coronoid process          | f. maxillary bone |
| <u>a</u> 7. Supraorbital margin       | g. occipital bone |
| <u>g</u> 8. Hypoglossal canal         | h. zygomatic bone |
| <u>b</u> 9. Foramen ovale             |                   |
| <u>e</u> 10. Crista galli             |                   |
| <u>c</u> 11. Internal acoustic meatus |                   |
| <u>b</u> 12. Hypophyseal fossa        |                   |
| <u>c</u> 13. Styloid process          |                   |
| <u>d</u> 14. The lower jaw bone       |                   |

### Labeling

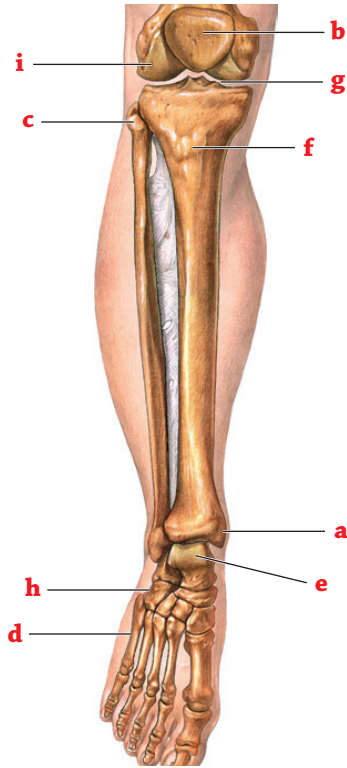
Draw your own lines and then label the following features on the diagram.

- |                     |                     |
|---------------------|---------------------|
| a. Xiphoid process  | f. 5th rib          |
| b. Head of radius   | g. Coronoid fossa   |
| c. Greater tubercle | h. Jugular notch    |
| d. Capitulum        | i. Acromion process |
| e. Coracoid process |                     |



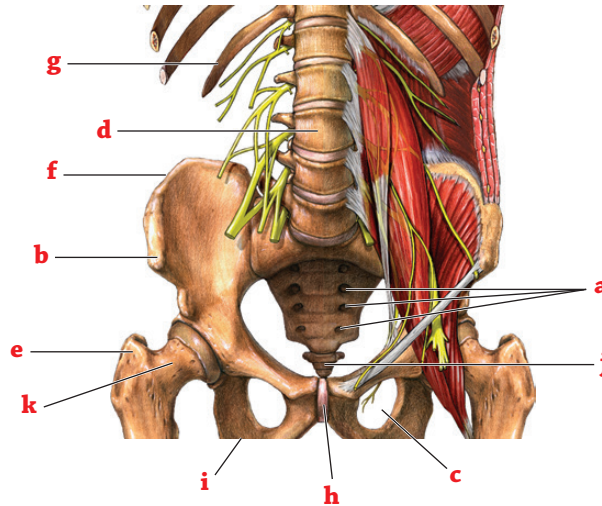
Draw your own lines and then label the following features on the diagram.

- |                            |                                    |
|----------------------------|------------------------------------|
| <b>a.</b> Medial malleolus | <b>f.</b> Tibial tuberosity        |
| <b>b.</b> Patella          | <b>g.</b> Intercondylar eminence   |
| <b>c.</b> Head of fibula   | <b>h.</b> Cuboid                   |
| <b>d.</b> 5th metatarsal   | <b>i.</b> Lateral condyle of femur |
| <b>e.</b> Talus            |                                    |



Draw your own lines and then label the following features on the diagram.

- |   |                              |
|---|------------------------------|
| <b>a.</b> Ventral sacral foramina       | <b>g.</b> 12th rib           |
| <b>b.</b> Anterior superior iliac spine | <b>h.</b> Pubic symphysis    |
| <b>c.</b> Obturator foramen             | <b>i.</b> Ischial tuberosity |
| <b>d.</b> Body of L3 vertebra           | <b>j.</b> Coccyx             |
| <b>e.</b> Greater trochanter            | <b>k.</b> Neck of femur      |
| <b>f.</b> Iliac crest                   |                              |



### Fill in the Blank/Short Answer

- The two bones that make up the nasal septum are the ethmoid and vomer.
- The four skull bones that contain paranasal sinuses are the frontal, sphenoid, ethmoid, and maxilla.
- The fontanelles of the skull typically close by what age? 2 years of age
- The cervical spine contains 7 vertebrae, the thoracic spine contains 12 vertebrae, and the lumbar spine has 5.
- The second cervical vertebra is also known as the axis.
- A lateral curvature of the spine is known as scoliosis.
- The clavicle articulates medially with the sternum (manubrium) and laterally with the clavicle.
- Ribs 8 to 10 are known as false or vertebrochondral ribs.
- The lateral border of the scapula is also known as the axillary border.
- The capitulum of the humerus articulates with the head of the radius.
- Digit 1 of the hand is also known as the thumb or pollex.
- The three bones that fuse to form the hip bone or os coxae are the ilium, ischium, and pubis.

13. When an elderly person with osteoporosis “breaks the hip,” the bone (and feature) that the person actually breaks is really the neck of the femur.
14. The bumps that most people refer to as the ankle are actually called the medial and lateral malleolus.
15. The great toe is properly known as the hallux, while the heel bone is more correctly called the calcaneous.

### Essay

1. Describe the normal developmental process of the primary and secondary curvatures of the spine and give some examples of abnormal curvatures.

Primary – develop in womb; convex to the posterior; thoracic and sacral secondary – convex to the anterior; cervical develops from “belly time;” lumbar develops with upright walking.  
Abnormal curves include scoliosis, kyphosis, and lordosis.
2. Compare and contrast several characteristics of osteoarthritis and rheumatoid arthritis.

OA – degenerative joint disease; common in weight bearing joints and joints of overuse; more common with an increase in age.  
RA – autoimmune disease; symmetrical/bilateral; joints eventually may fuse; more common in middle age; more common in females than males.