Typical Long Bone

Bones are composed of two types of bone tissue: **compact** and **spongy**. Compact bone is densely packed with calcified salt and thus is very strong. It is also very heavy, and for this reason only the outer layer of bone has compact bone tissue. Spongy bone has many spaces within its matrix, which are filled with bone marrow. The holes make this tissue much weaker, but lighter. Spongy bone is found inside of our bones.

Bones can be classified based on their shape. There are **long bones**, **short bones**, **flat bones** and **irregular bones**. Here we are looking at the parts of a typical long bone.

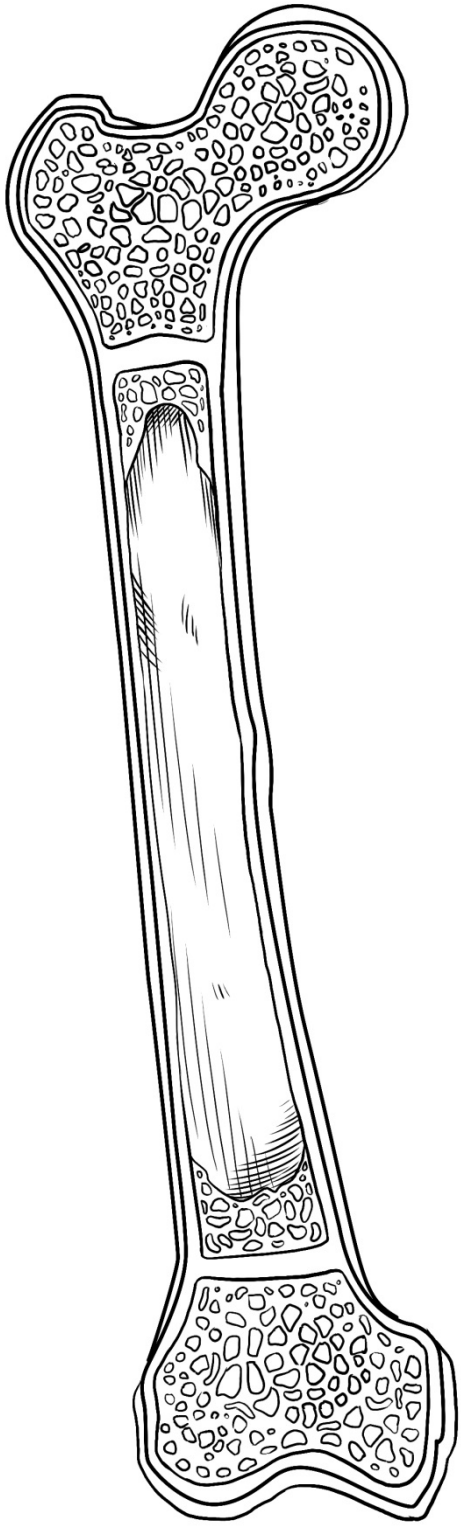
The **epiphyses** (singular: epiphysis) are the proximal and distal ends of the long bones. The shaft is called the **diaphysis**. Within the diaphysis is a cavity called the **medullary cavity**, which contains bone marrow. In most adult bones, the medullary cavity is predominately filled with **yellow bone marrow** (fat). There may still be some **red bone marrow**, which contains hematopoietic stem cells to produce new blood cells. When the bone is still growing in length, the junction between the epiphysis and diaphysis – called the **epiphyseal growth plate** – is composed of hyaline cartilage, which provides the framework for new bone growth. Once the skeleton is mature, that cartilage is replaced by compact bone to form the **epiphyseal line**.

Activity:

1. Describe the different bone types (e.g. long, short, etc.) and give examples of each.
2. What is found inside of the medullary cavity?
3. What are some differences between spongy and compact bone?
4. Identify the following:

- ☐ Compact bone
- ☐ Diaphysis
- ☐ Distal epiphysis
- ☐ Epiphyseal line
- ☐ Medullary cavity
- ☐ Proximal epiphysis
- ☐ Spongy bone

Typical Long Bone



The Osteon

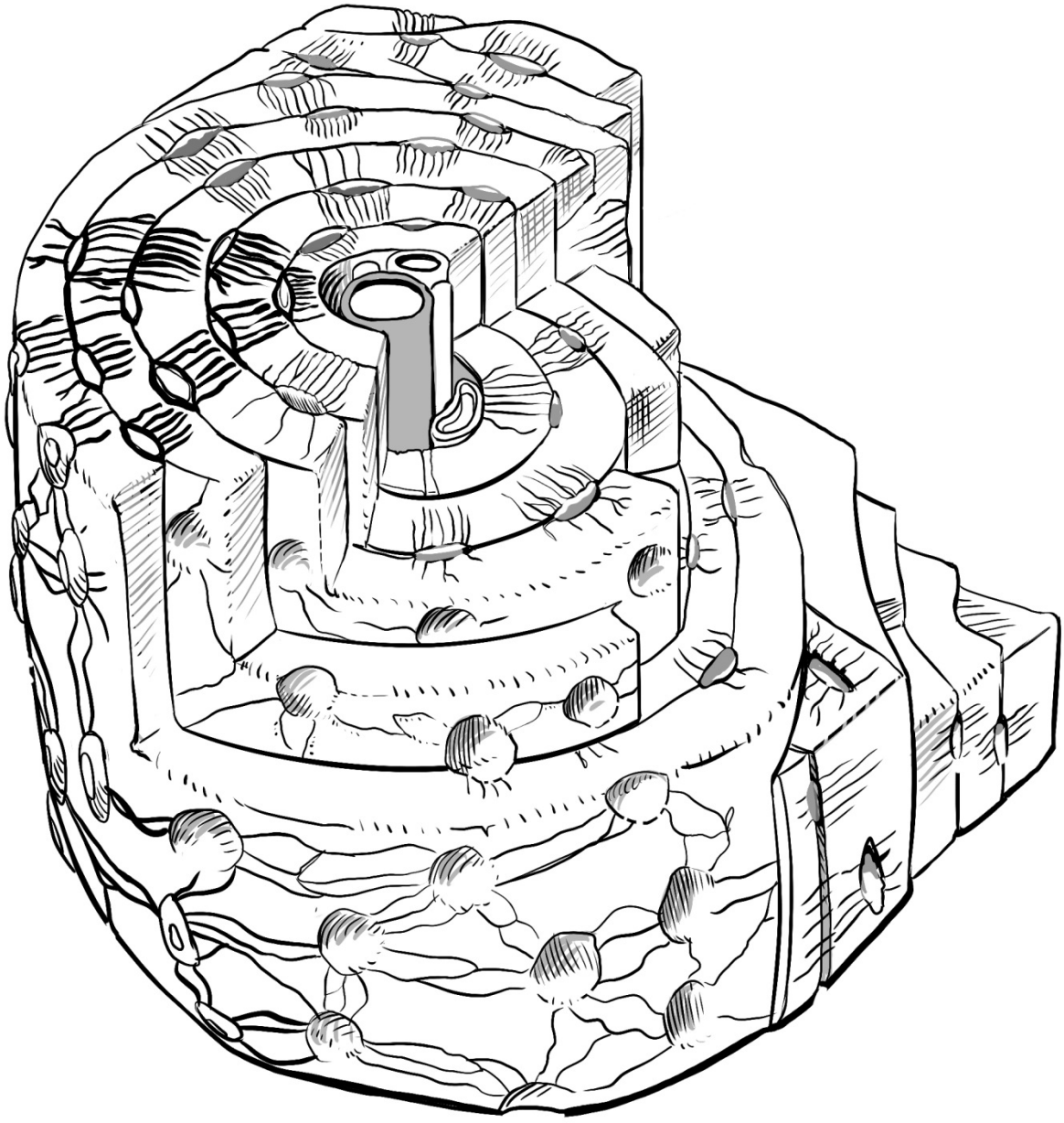
Compact bone is arranged in **osteons** (also called Haversian systems). These cylindrical structures run down the length of the bone, providing strength. Down the middle of the osteon is the **central canal**, which contains an artery, a vein, nerves and a lymphatic vessel. Concentric layers of bone matrix, called **lamellae** (singular: lamella), surround the central canal. Small gaps between the lamellae are called **lacunae** (singular: lacuna); bone cells, **osteocytes**, reside here. Osteocytes are oddly shaped cells; they have long projections. Those projections are found within tiny grooves in the lamellae called **canaliculi** (singular: canaliculus).

Activity:

1. Are osteons found in spongy or compact bone?
2. Identify the following:

- ☐ Canaliculus
- ☐ Central canal
- ☐ Lacuna
- ☐ Lamella
- ☐ Osteocyte

The Osteon



Bone Histology

Once you are familiar with the generalized structure of bone tissue, you should be able to identify many of the features on prepared and stained sections of compact bone.

This slide is a transverse section of compact bone tissue. Note that you can see several osteons. Filling in the spaces between osteons are interstitial lamellae, which are remnants of old osteons that underwent remodeling.

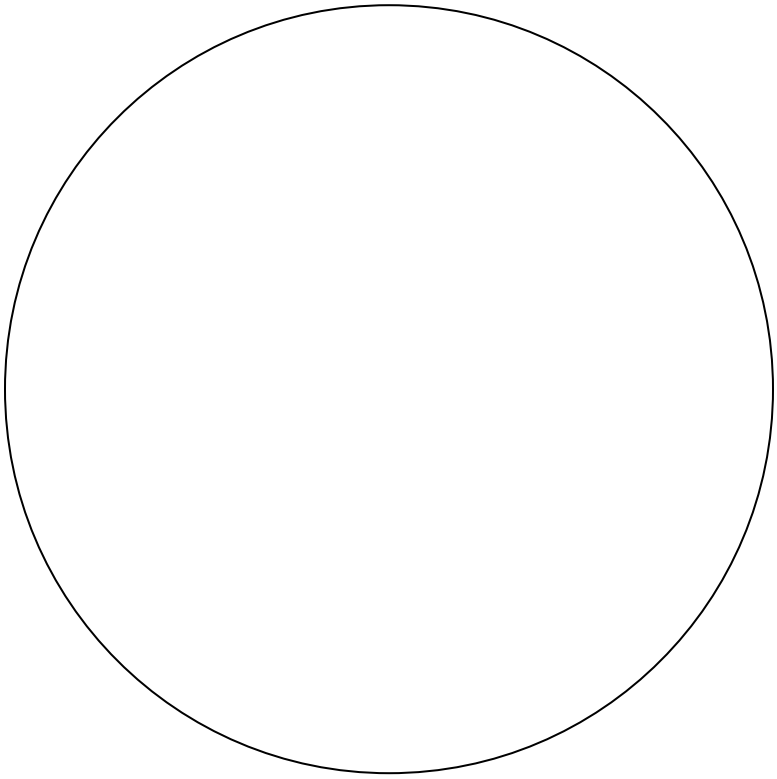
Activity:

1. Obtain slide number 32 from your slide box.
2. Using the 10X objective lens, locate the following:

    Central canal
    Concentric lamellae
    Lacunae

3. Draw what you see on the following page, labelling the structures listed above.

Bone Histology



The Skull
(Anterior View)

The skull is composed of 22 bones. The eight **cranial** bones encase the brain, whereas the 14 **facial** bones form the features of our face.

From this perspective, you can see several of the cranial bones. The **frontal** bone forms the forehead. In the majority of people, this is a single bone; a small proportion of the population has paired frontal bones fused along the mid-sagittal plane. The paired **temporal** bones form the temples. The paired **parietal** bones form the superior-most portion of the cranium. In the orbit where the eye is found, you can see two more cranial bones: the **ethmoid** bone in the medial wall of the orbit and the **sphenoid** bone in the posterior of the orbit.

Many of the facial bones can also be observed from the anterior perspective. The paired **zygomatic** bones form the cheekbones. The paired **nasal** bones form the bridge of the nose. The paired **maxillary** bones form the upper jaw, while the single **mandible** forms the lower jaw. The paired **lacrimal** bones can be found near the orbits, just posterior to the nasal bones and anterior to the ethmoid bone. Within the nasal cavity, the **vomer** can be seen, which forms the inferior portion of the nasal septum. Finally, the paired **inferior nasal conchae** can be found on the lateral wall within the nasal cavity. These bones form inferior ridges in the nasal cavity called turbinates, which warm the air we inhale; we will be looking at the nasal cavity more closely in a subsequent drawing.

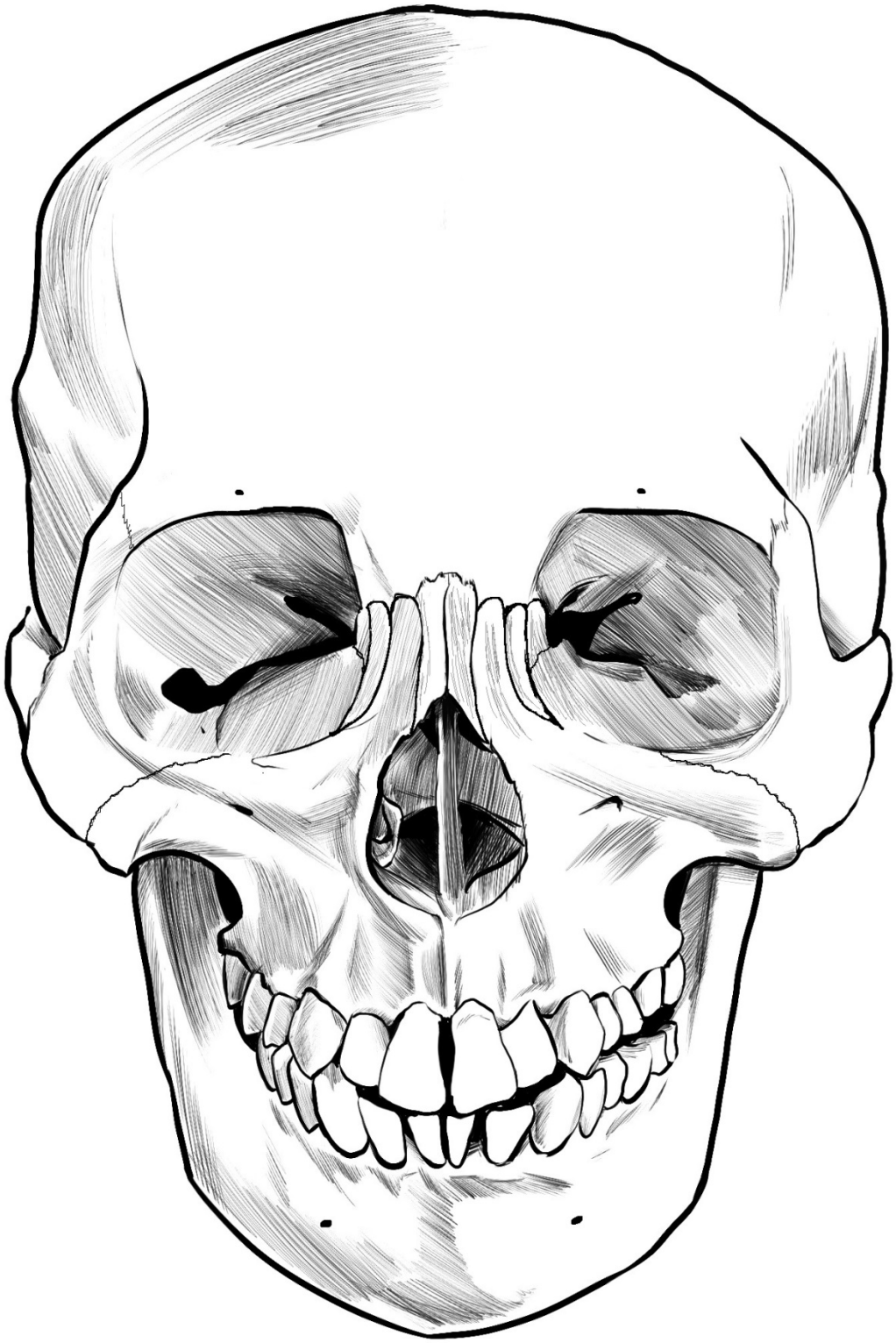
Activity:

1. Identify the bones:

☐ Ethmoid	☐ Mandible	☐ Sphenoid
☐ Frontal	☐ Maxilla	☐ Temporal
☐ Inferior nasal conchae	☐ Nasal	☐ Vomer
☐ Lacrimal	☐ Parietal	☐ Zygomatic

2. Which of the bones listed above are cranial bones? Which are facial bones?
3. Which of the bones are paired? Single?

The Skull
(Anterior View)



The Skull
(Lateral View)

The lateral view of the skull allows you to see the last of the cranial bones, the **occipital** bone which forms the posterior and inferior portions of the cranium. This perspective also allows you to see the entire shape of the **parietal** and **temporal** bones on the lateral sides of the cranium. You can also see where the **frontal** bone joins the parietal bone. Just anterior to the temporal bone and posterior to the zygomatic bone, you can see the lateral portion of the **sphenoid** bone. On the medial wall of the orbit, you can see a small sliver of the **ethmoid** bone.

Several of the facial bones can also be seen, including the **zygomatic**, **maxilla**, **mandible**, **nasal**, and **lacrimal** bones.

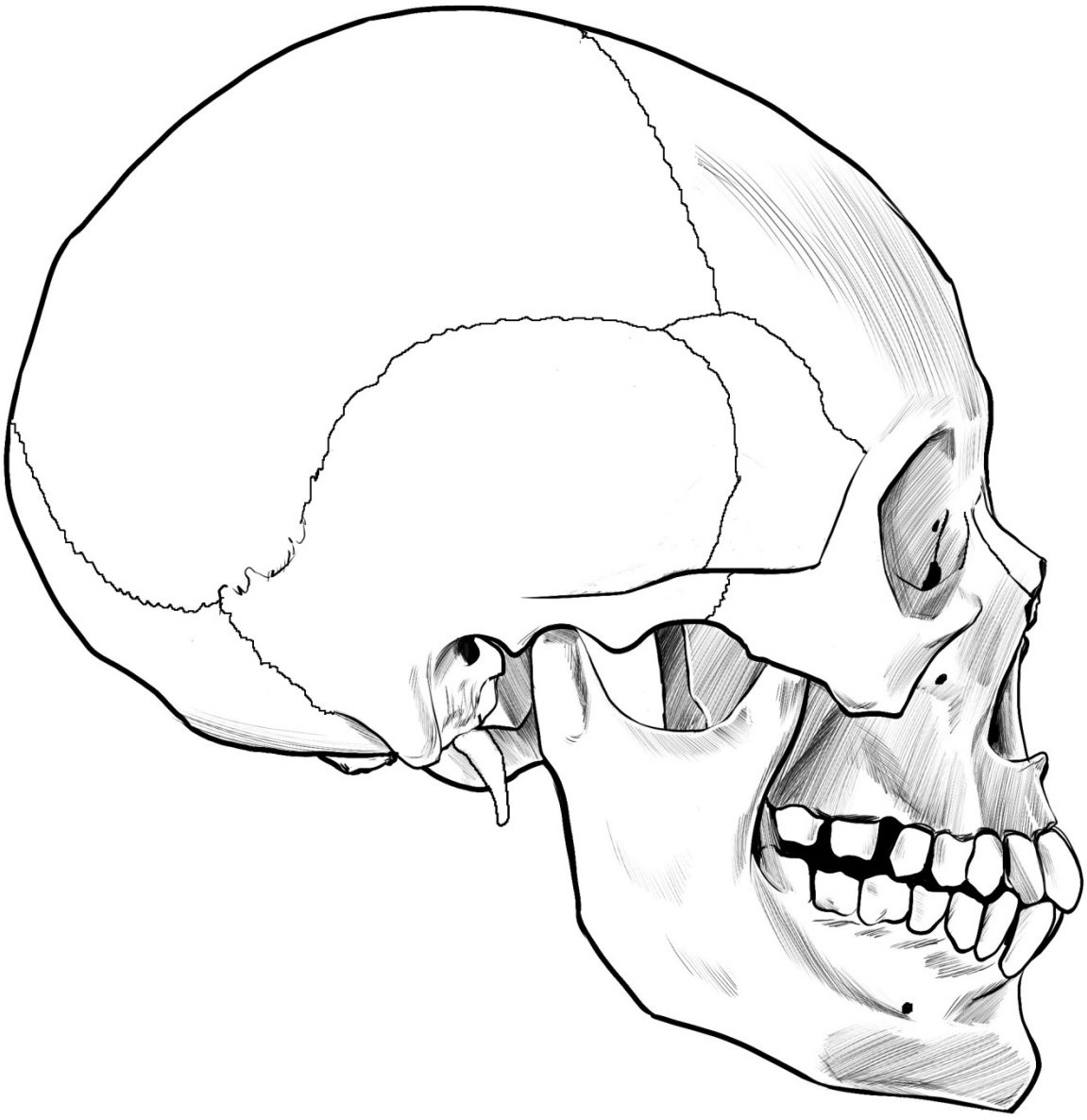
Activity:

1. Identify the bones:

☐ Ethmoid	☐ Maxilla	☐ Sphenoid
☐ Frontal	☐ Nasal	☐ Temporal
☐ Lacrimal	☐ Occipital	☐ Zygomatic
☐ Mandible	☐ Parietal	

2. Which of the bones listed above are cranial bones? Which are facial bones?
3. Which of the bones are paired? Single?

The Skull
(Lateral View)



The Skull
(Posterior View)

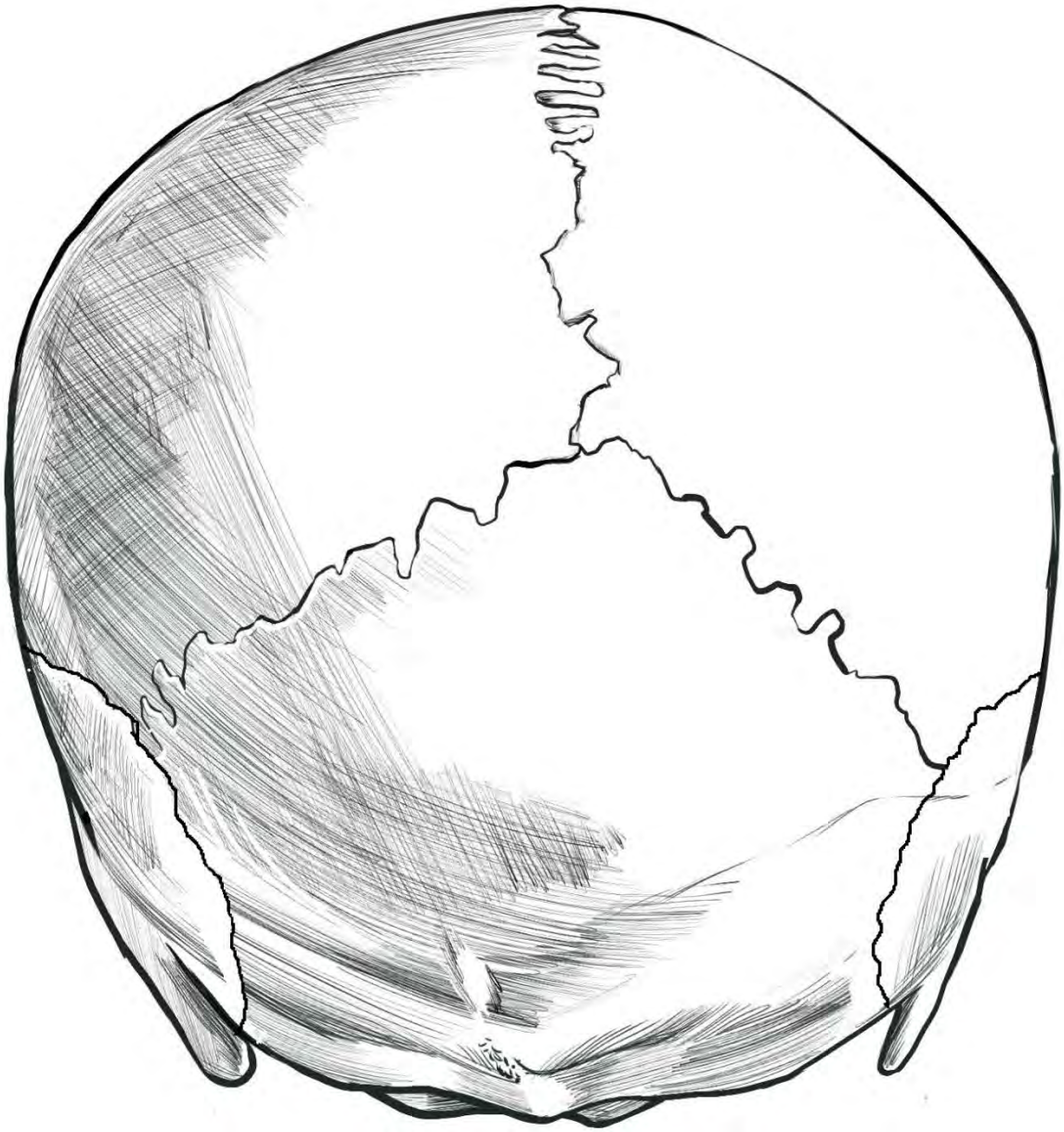
The posterior view of the skull allows you to see the posterior portion of the **parietal** and **occipital** bones. On the inferior, lateral portion of the posterior skull you can also see a small section of the **temporal** bone.

Activity:

1. Identify the bones:

☐ Occipital ☐ Parietal ☐ Temporal

The Skull
(Posterior View)



The Skull
(Inferior View)

Turning the skull upside down, you can see the remainder of the **occipital** bone, which forms the floor of the cranium. Just lateral to the occipital bone you can see the **temporal** bones and a small portion of the **parietal** bones.

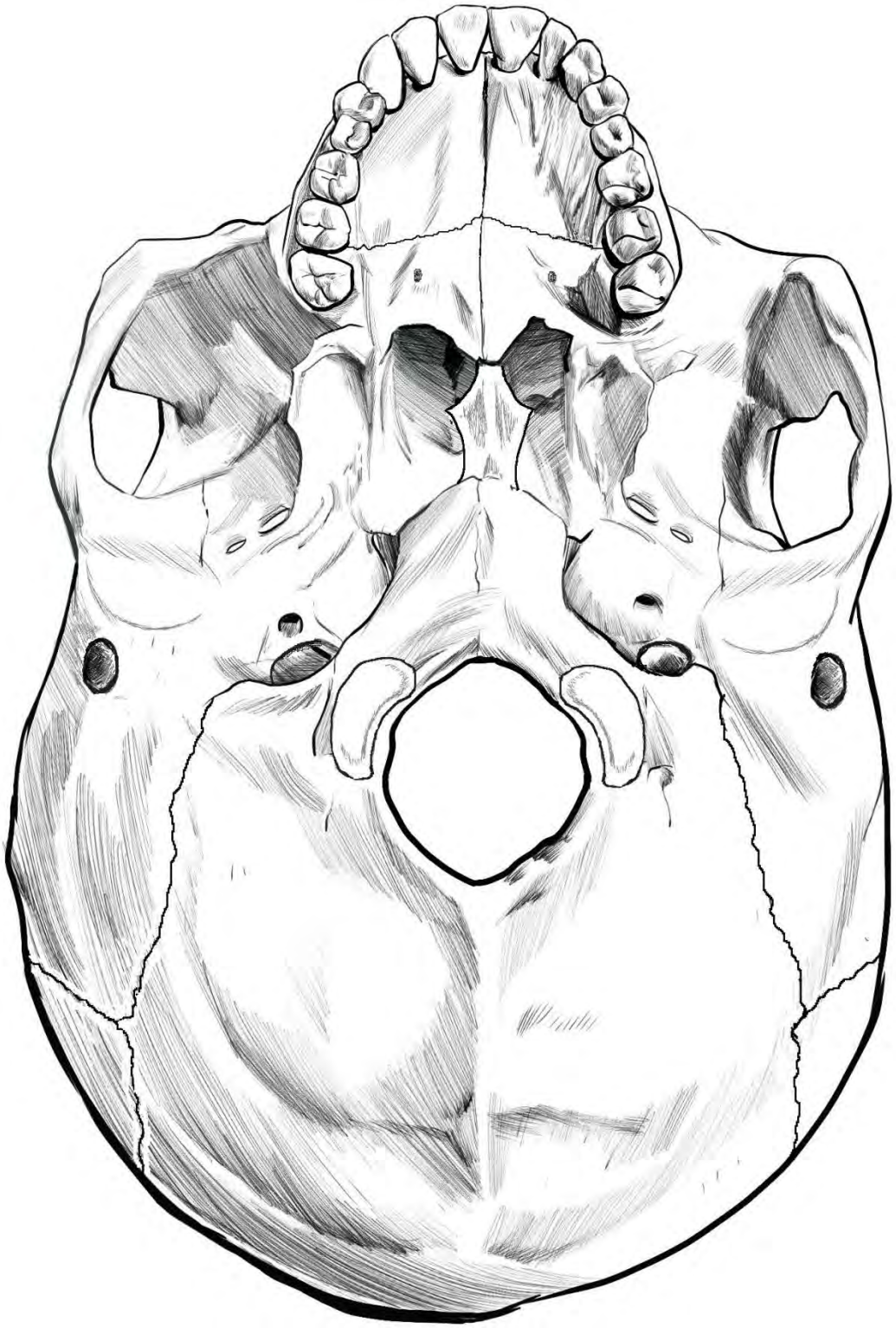
This perspective allows you to see the last of the facial bones – the **palatine** bones. These bones form the posterior part of the hard palate on the roof of the mouth. You can also see the underside of the **sphenoid** bone; this is the first perspective where the characteristic butterfly shape of this bone can be seen. In between the palatine bones and the sphenoid bone is the **vomer**. You can also see the underside of the **maxillary** bones and a small section of the **zygomatic** bones.

Activity:

1. Identify the bones:

☐ Maxilla	☐ Palatine	☐ Vomer
☐ Occipital	☐ Sphenoid	☐ Zygomatic
☐ Parietal	☐ Temporal	

The Skull
(Inferior View)



The Skull
(Internal View)

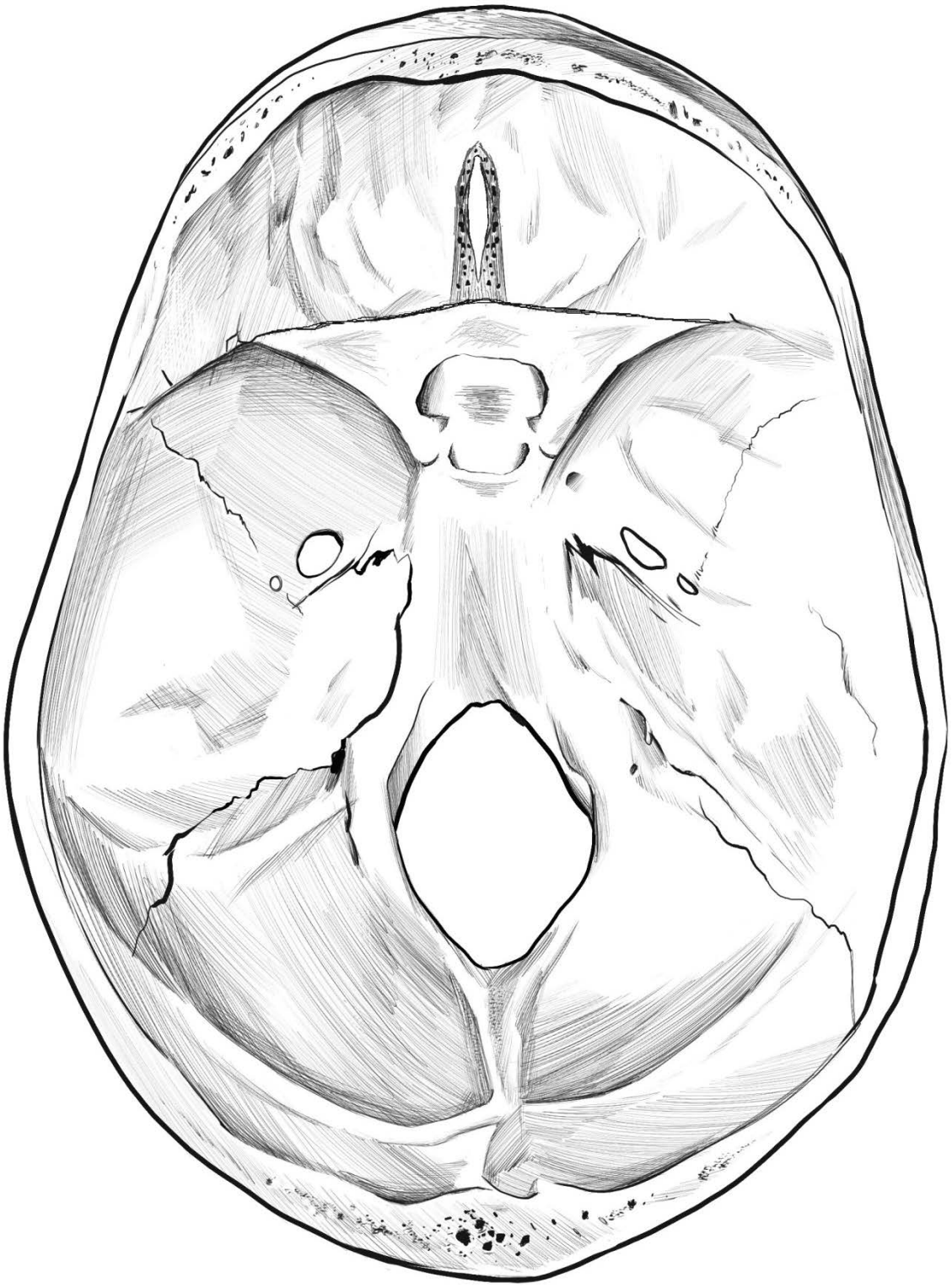
In this view, the top of the skull was removed so you can see into the internal chamber of the skull. This perspective provides the best view of the **ethmoid**, the small, irregularly shaped bone buried in the middle of the frontal bone. This view also shows the superior portion of the **sphenoid** bone, which, like the previous drawing, allows you to see the characteristic butterfly shape of the bone. You can also see portions of the **parietal**, **temporal** and **occipital** bones.

Activity:

1. Identify the bones:

☐ Ethmoid	☐ Occipital	☐ Sphenoid
☐ Frontal	☐ Parietal	☐ Temporal

The Skull
(Internal View)



The Skull
(Anterior View)

We are revisiting the anterior view of the skull to identify features of the different cranial and facial bones. The frontal bone includes a **supraorbital margin**, a ridge above the orbit that forms the eyebrow. These margins are sexually dimorphic; they are usually larger in men than in women. Features of the ethmoid bone can be seen within the nasal cavity. The **perpendicular plate** is a ridge of the bone that forms the superior portion of the nasal septum, separating the nasal cavity into its two halves. On both lateral sides of the perpendicular plate are the **middle nasal conchae**, masses that extend into the nasal cavity. The conchae are involved in warming and humidifying the air as it is breathed in; we will discuss this in further detail later. The mandible has holes called **mental foramina**, through which blood vessels and nerves pass. The teeth of both the upper and lower jaws rest in the **alveoli** of the maxilla and mandible.

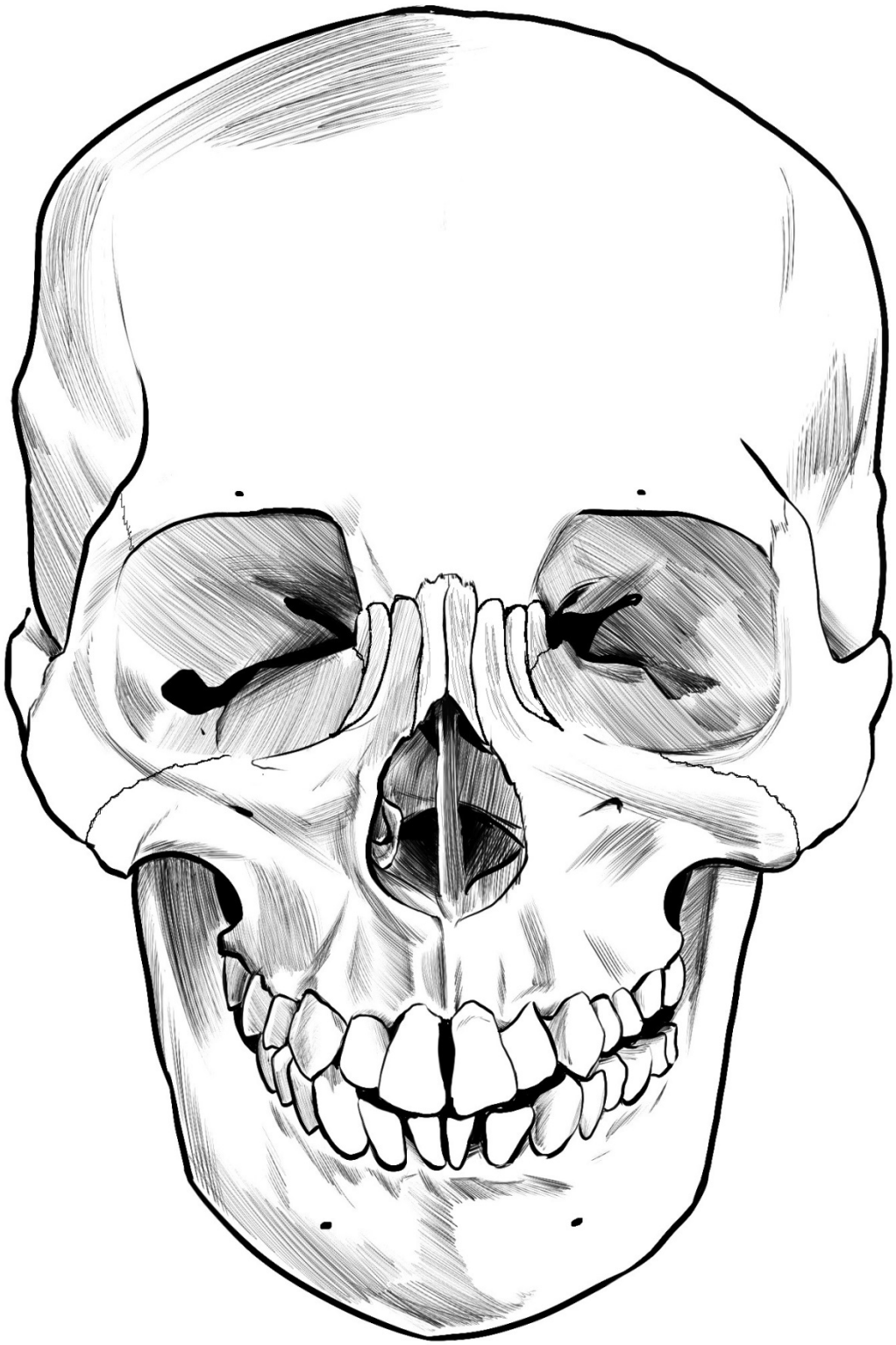
Activity:

1. Identify the following bony features:

☐	Alveolar margin of mandible	☐	Middle nasal concha
☐	Alveolar margin of maxilla	☐	Perpendicular plate
☐	Mental foramen	☐	Supraorbital margin

The Skull

(Anterior View)



The Skull
(Lateral View)

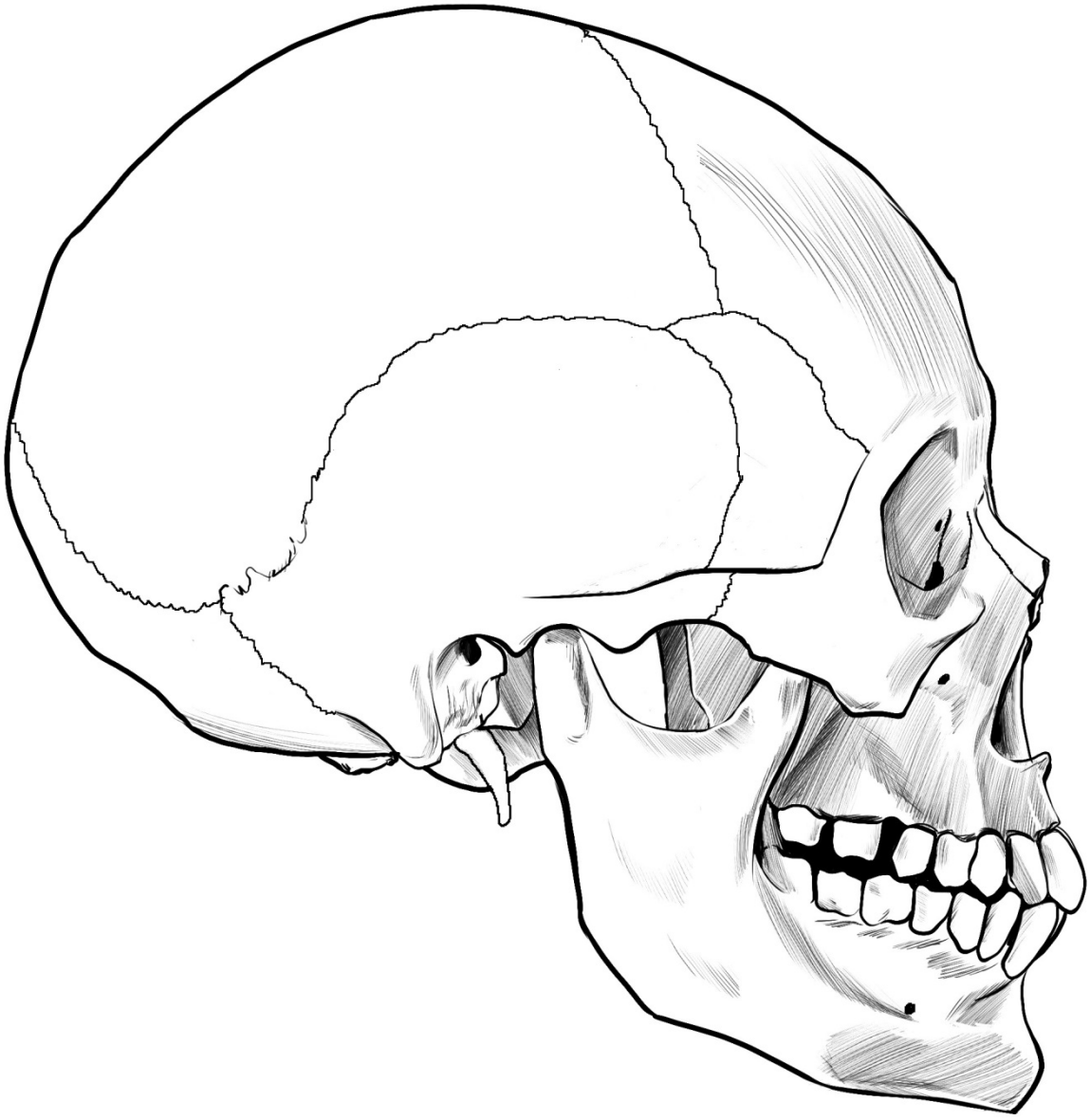
We are revisiting the lateral view of the skull to identify features of the different cranial and facial bones. Three of the skull's sutures can be seen from this perspective. The sutures are formed by articulations between the cranial bones. The **coronal suture**, which follows the coronal plane, connects the frontal bone to the parietal bones. The **squamous suture** connects the parietal and temporal bones. The **lambdoid suture** connects the parietal and occipital bones. The lacrimal bone has the **lacrimal fossa**, which is a groove that contains a lacrimal sac for draining tears into the nose. This is a landmark that can help you distinguish the lacrimal bones from the nasal and ethmoid bones. You can see the **alveolar margins** of the mandible and maxilla, where the teeth are found. Also on the mandible, the **mental foramen** can be seen, as well as the **mandibular condyle**, which articulates with the temporal bone at the jaw. This perspective allows you to see the **angle of the mandible**, another sexually dimorphic trait, which usually has a right angle in males and a more obtuse angle in females. Several features of the temporal bone can be seen from this view. The **zygomatic process** of the temporal bone articulates with the zygomatic bone, to form the **zygomatic arch**, or lateral ridge of the cheekbone. The **external acoustic meatus**, or ear canal, allows sounds waves to be transmitted toward the inner ear. The **mastoid process** is a large projection that points downward, and provides an attachment site for muscles. The **styloid process** sits anterior to the mastoid process, and is much thinner and more delicate; it also provides an attachment site for muscles.

Activity:

1. Identify the following bony features:

- ☐ Alveolar margin of mandible
- ☐ Alveolar margin of maxilla
- ☐ Coronal suture
- ☐ External acoustic meatus
- ☐ Lacrimal fossa
- ☐ Lambdoid suture
- ☐ Mandibular angle
- ☐ Mandibular condyle
- ☐ Mastoid process
- ☐ Mental foramen
- ☐ Squamous suture
- ☐ Styloid process
- ☐ Zygomatic process

The Skull
(Lateral View)



The Skull
(Posterior View)

We are revisiting the posterior view of the skull to identify features of the different cranial and facial bones. Two of the sutures can be viewed from the posterior view. The **sagittal suture**, which follows the sagittal plane, connects the two parietal bones. The **lambdoid suture** connects the occipital bone to the two parietal bones; this suture is shaped like an upside down V, which is similar to the structure of the Greek letter, lamda (λ). A feature of the occipital bone can be seen from this perspective: the **external occipital protuberance**, often referred to as the inion. This bump on the back of the skull, which is an attachment site for muscles, varies in size between individuals.

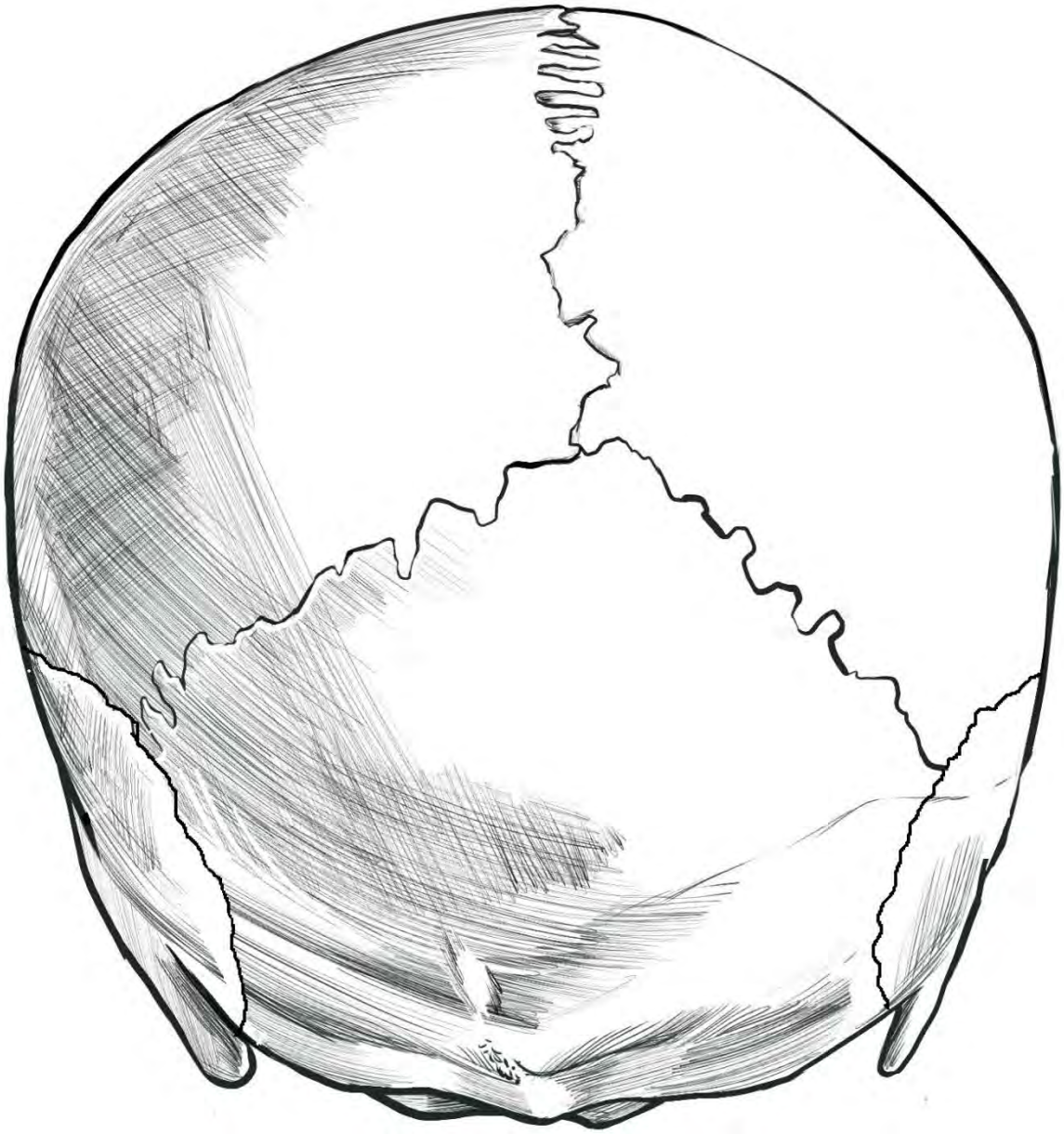
Activity:

1. Identify the following bony features:

- ☐ External occipital protuberance
- ☐ Lambdoid suture
- ☐ Sagittal suture

The Skull

(Posterior View)



The Skull
(Inferior View)

We are revisiting the inferior view of the skull to identify features of the different cranial and facial bones. The hard palate, which separates the nasal from the oral cavity, can be viewed from the inferior perspective. Recall that the paired palatine bones form the posterior portion of the hard palate. The anterior portion is formed by the **palatine processes** of the maxillary bones. Connecting the right and left palatine processes and right and left palatine bones is the **median palatine suture**. The **zygomatic processes** and the **external acoustic meatus** of the temporal bone can be seen, as well as the **mandibular fossa**, the groove in the temporal bone that articulates with the mandibular condyle to form the temporomandibular joint (the jaw). Several features of the occipital bone can be seen, including the **external occipital protuberance**, which was previously discussed. The **foramen magnum** is a large hole that allows the spinal cord to connect to the brainstem. Just lateral to the foramen magnum are the right and left **occipital condyles**, which are convex, kidney-shaped surfaces that articulate with the first vertebra.

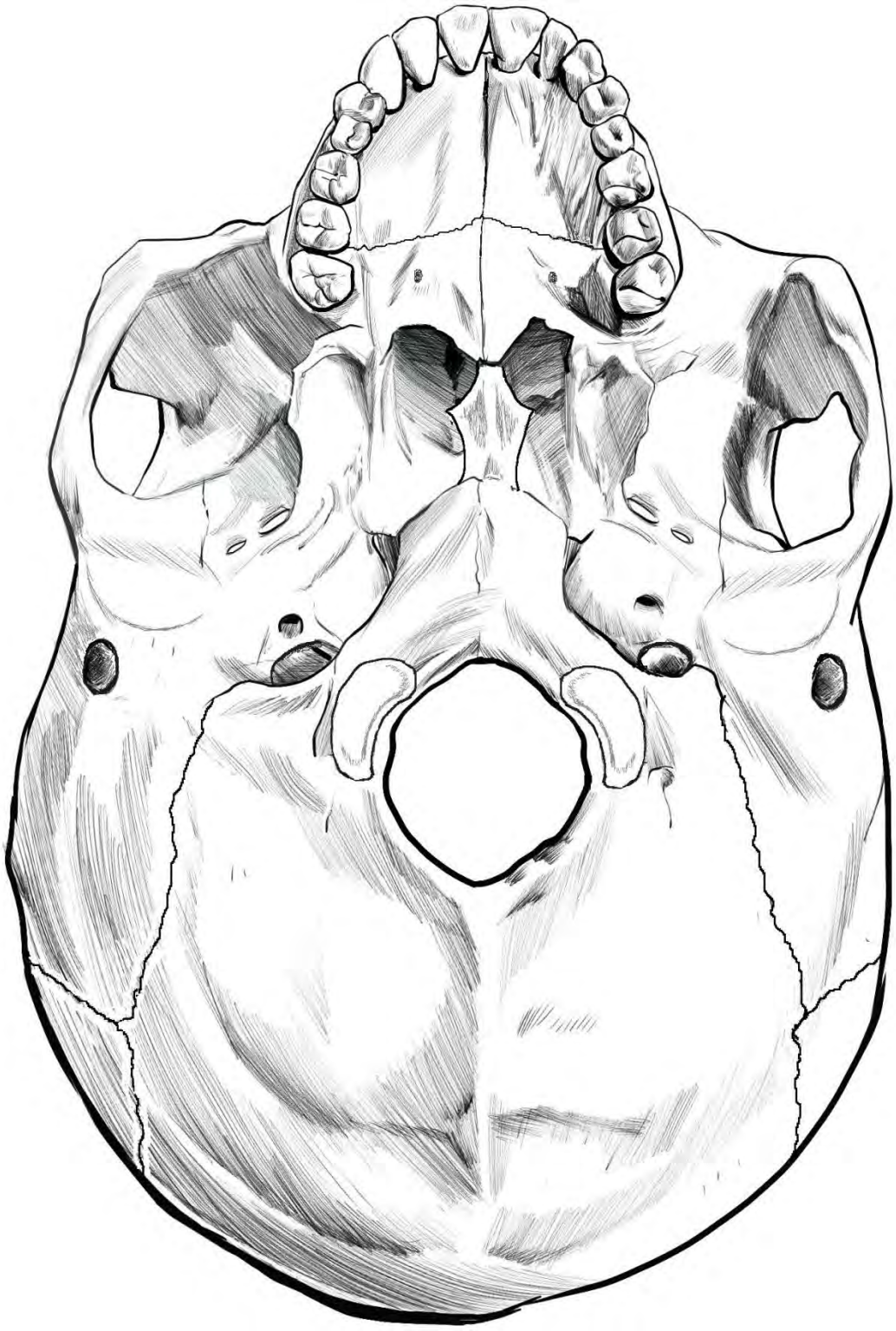
Activity:

1. Identify the following bony features:

☐	External acoustic meatus	☐	Median palatine suture
☐	External occipital protuberance	☐	Occipital condyles
☐	Foramen magnum	☐	Palatine process
☐	Mandibular fossa	☐	Zygomatic process

2. What structures form the hard palate?

The Skull
(Inferior View)



The Skull
(Internal View)

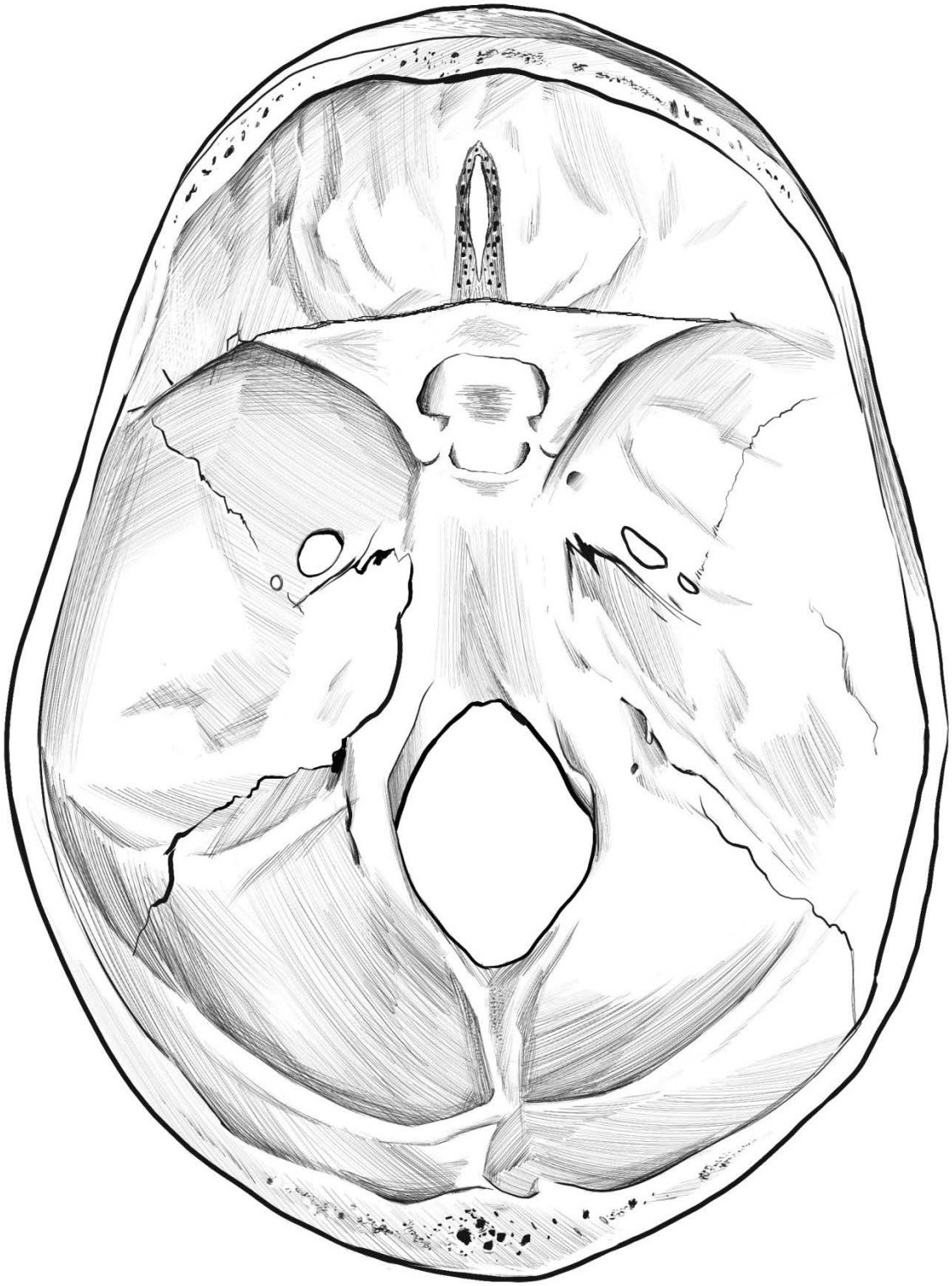
We are revisiting the internal view of the skull to identify features of the different cranial and facial bones. Features of the ethmoid bone include a central ridge, called the **crista galli**, which is an attachment site for a membrane that holds the brain in place, and a pair of plates on its lateral sides called the **cribiform plates**, which contain holes through which olfactory nerves run. The butterfly-shaped sphenoid bone has smaller, more anterior **lesser wings** and larger, most posterior **greater wings**. The body of the sphenoid bone includes the **sella turcica** ("Turkish saddle"), in which the pituitary gland rests. Two regions of the temporal bone can be identified. The **petrous portion** of the temporal bone is the hardest region of the skull and houses the tiny, delicate middle and inner ear structures that are vital for hearing and balance. Just as the temporal bone had an external acoustic meatus on its exterior surface, it has an **internal acoustic meatus** on its internal surface. Cranial nerves run though this meatus.

Activity:

1. Identify the following bony features:

- ☐ Cribiform plate
- ☐ Crista galli
- ☐ Greater wings
- ☐ Internal acoustic meatus
- ☐ Lesser wings
- ☐ Petrous portion
- ☐ Sella turcica

The Skull
(Internal View)



The Nasal Cavity

The **nasal cavity** consists of bone and cartilage lined by a mucous membrane that filters, warms and humidifies the air before it enters the lungs. Above the nasal cavity is the cribiform plate, which supports the olfactory nerves. Below is the hard palate, which separates the nasal from the oral cavity. Behind the nasal cavity is the sphenoid bone. Surrounding the cavity in adults are the paranasal sinuses, which are cavities within skull bones that are lined by the same mucous membrane. The sinuses are named: **frontal, sphenoid, maxillary and ethmoid sinuses.** The latter two cannot be seen on this image.

The first image, of the lateral walls of the nasal cavity, allows you to see the nasal conchae. The **superior and middle nasal conchae** are features of the ethmoid bone. The **inferior nasal concha** is a separate bone. Each concha has a corresponding groove underneath it: **superior, middle and inferior nasal meatus**. These structures act as turbinates, causing the air to swirl around as it is being humidified and warmed.

The second image is of the **nasal septum**, which separates the nasal cavity into right and left halves. It is mostly composed of bone, but has cartilage as well to give it some flexibility. The top portion of the septum is formed by the **perpendicular plate** of the ethmoid bone. The bottom portion is formed by the **vomer**. In between these two bones is the **septal cartilage**, composed of hyaline cartilage. Two of the paranasal sinuses can also be seen on this image. The **frontal sinus** is superior and anterior to the perpendicular plate; whereas the **sphenoid sinus** is posterior to the septum.

Activity:

1. Identify the parts of the nasal cavity:

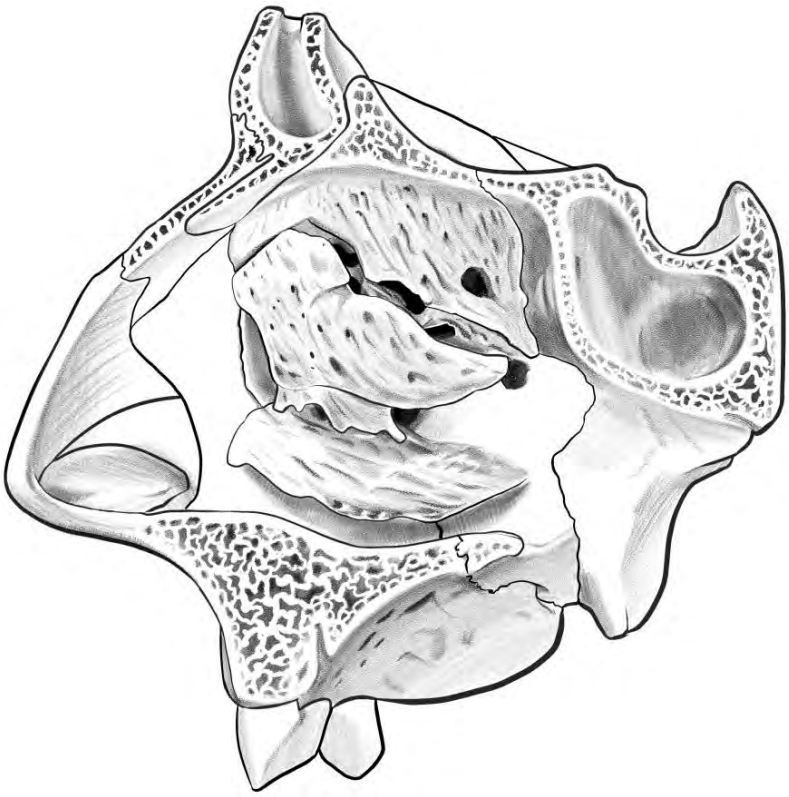
☐	Frontal sinus	☐	Middle nasal concha
☐	Inferior meatus	☐	Sphenoid sinus
☐	Inferior nasal concha	☐	Superior meatus
☐	Middle meatus	☐	Superior nasal concha

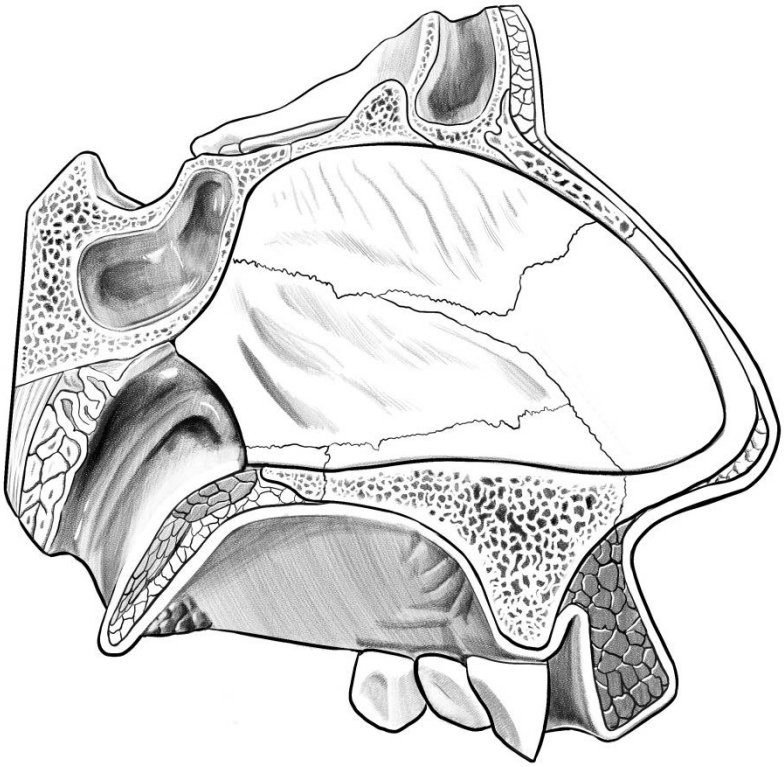
2. Identify the parts of the nasal septum:

☐	Frontal sinus	☐	Sphenoid sinus
☐	Perpendicular plate	☐	Vomer
☐	Septal cartilage		

3. Besides the two sinuses listed above, what are the other paranasal sinuses?

The Nasal Cavity





The Orbit

The **orbits** house the eyes. Seven different bones contribute to the orbit. The superior orbit is formed by the **frontal** bone. The lateral orbit is formed by the **zygomatic** bone. The base of the orbit is formed by the **maxillae** and **palatine** bones. The medial orbit is formed by the **lacrimal** and **ethmoid** bones. The posterior of the orbit is formed by the **sphenoid** bone.

Activity:

1. Identify the following bones of the orbit:

- ☐ Ethmoid
- ☐ Frontal
- ☐ Lacrimal
- ☐ Maxilla
- ☐ Palatine
- ☐ Sphenoid
- ☐ Zygomatic

The Orbit

The Typical Vertebra
(Superior and Lateral Views)

This image will allow you to study the features of a typical vertebra. Once you have an understanding of general characteristics, you will learn about the unique characteristics associated with each type of vertebra.

Vertebrae have two basic parts which surround a hole in the center called the **vertebral foramen**; the spinal cord runs through this foramen. The anterior portion of the vertebra is the **body**, which bears the most weight, and is therefore the largest part. **Intervertebral discs**, with their tough outer **annulus fibrous** and gelatinous inner **nucleus pulposus**, rest between the bodies of the vertebrae, absorbing shock. The remainder of the vertebra is the **vertebral arch**, which includes several regions. The most lateral parts, extending to the right and left, are the **transverse processes**. The **pedicles** connect the transverse processes to the body. The most posterior region of the vertebra is the **spinous process**, which provides an attachment site for muscles and can be felt as you run your fingers down the spine. The **laminae** connect the spinous process to the transverse processes. **Superior articular processes and facets** are located on the top surface of the vertebra, at the points where the laminae and pedicles meet; there are also **inferior articular processes and facets** on the inferior surface. The superior facet articulates with the inferior facet of the vertebra just above it; the inferior facet articulates with the superior facet of the vertebra just below it.

When the vertebral column is viewed from the side, you can see **intervertebral foramina**, which form from notches on the superior and inferior surfaces of the pedicles. Spinal nerves run through these foramina.

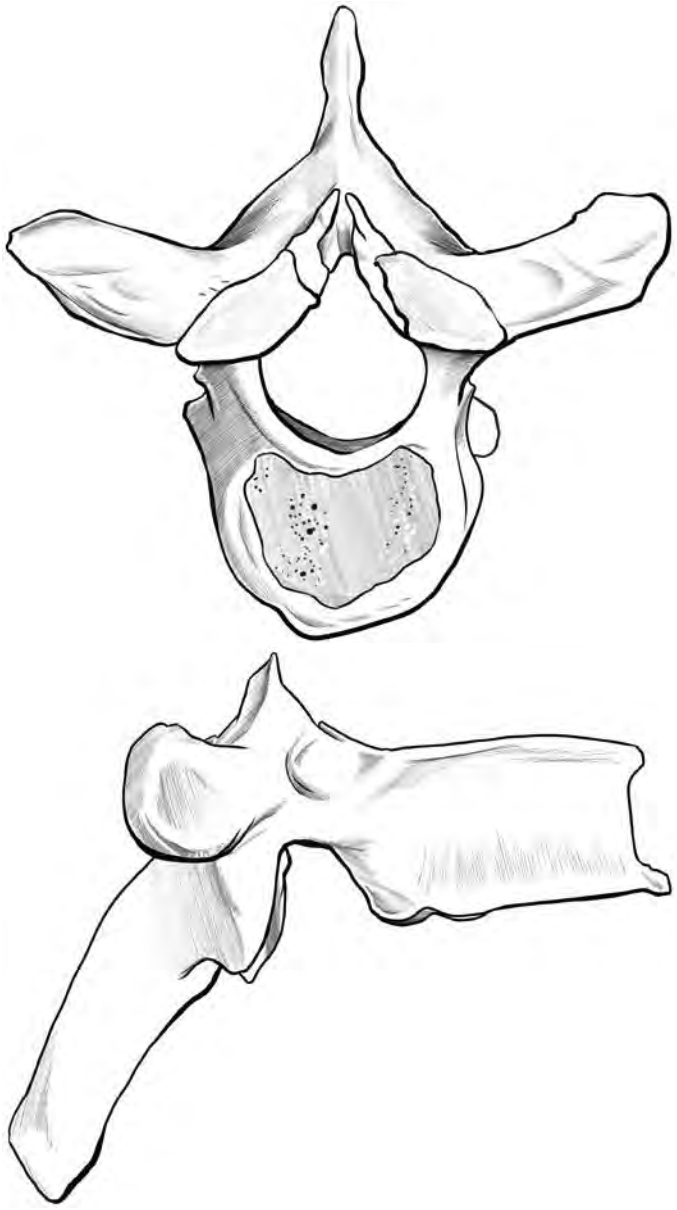
Activity:

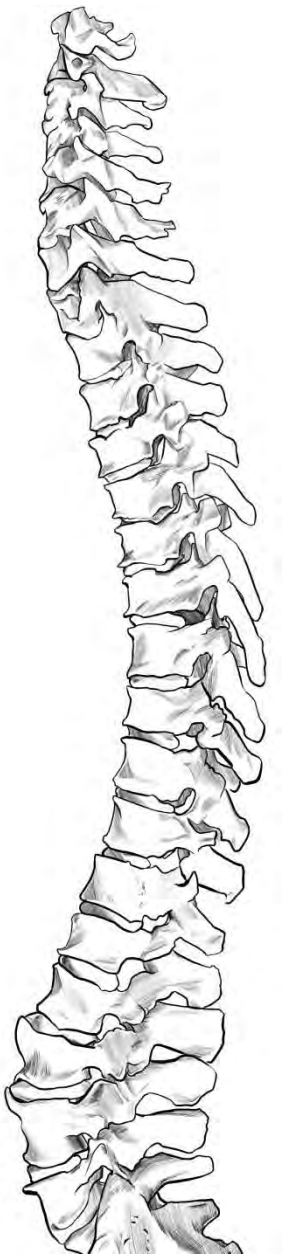
1. Identify the following bony features:

☐	Body	☐	Spinous process
☐	Inferior articular process and facet	☐	Superior articular process and facet
☐	Intervertebral foramen	☐	Transverse process
☐	Lamina	☐	Vertebral arch
☐	Pedicle	☐	Vertebral foramen

Mnemonic for regions:
Blood Pressure Tests (are) Life Saving

The Typical Vertebra
(Superior and Lateral Views)





The Vertebral Column
(Lateral View)

The **vertebral column** extends from the skull to the pelvis, and houses and protects the spinal cord. This image is showing the vertebral column from the lateral perspective; the anterior surface is on the left side of the image, and the posterior surface is on the right side of the image. It is composed of 26 bones that are separated by fibrocartilaginous discs called **intervertebral discs**, which act as shock absorbers.

There are five different regions of the vertebral column, each with vertebrae that have distinct morphological traits that will be discussed shortly. The column begins with seven **cervical** vertebrae in the neck region, then 12 **thoracic** vertebrae through the thorax, and then five **lumbar** vertebrae in the lower back. Below the lumbar vertebrae are five fused vertebrae, collectively referred to as the **sacrum**; the sacrum forms the posterior region of the pelvis. The inferior-most region of the vertebral column is the **coccyx**, which is composed of three to five fused vertebrae; this area is commonly referred to as the tail bone, and is a vestige from development.

The lateral perspective allows you to see the curvatures of the spine. The **cervical curvature** is concave; the **thoracic curvature** is convex; the **lumbar curvature** is concave; and the **sacral curvature** is convex. These curvatures give the spinal column a characteristic S shape, and provide flexibility during walking. Babies are born with thoracic and sacral curvatures; these curvatures are referred to as primary curvatures. The cervical curvature develops once we learn how to hold our head up. The lumbar curvature develops once we learn how to walk. The latter two curvatures are therefore referred to as secondary curvatures.

Activity:

1. Identify the following structures:

☐ Cervical curvature	☐ Lumbar curvature	☐ Sacrum
☐ Cervical vertebrae	☐ Lumbar vertebrae	☐ Thoracic curvature
☐ Coccyx	☐ Sacral curvature	☐ Thoracic vertebrae

2. How many vertebrae are there within each type listed above?
3. What is the purpose of the intervertebral discs?
4. What is the purpose of the spinal curvatures? Which are primary? Which are secondary and what makes them secondary?

The Vertebral Column

(Lateral View)

Atlas and Axis
(Superior View)

Recall that there are seven cervical vertebrae, numbered C1-C7, in the neck region of the vertebral column. These are the smallest of all the vertebrae because the bear the least amount of weight. The first two cervical vertebrae are worth special attention because they have unique features.

C1, also called **atlas**, articulates with the skull. It lacks the structures found in a typical vertebra, including a body and spinous process. Instead, there is an **anterior arch** and a **posterior arch** surrounding the **vertebral foramen**, which is very large to accommodate the spinal cord that is wide at this point. The **superior articular facets** articulate with the occipital condyles, allowing for flexion and extension of the head like nodding "yes". The **inferior articular facets** articulate with C2. There are short **transverse processes**, with small holes in them called **transverse foramina**, through which the vertebral arteries pass.

C2, also called **axis**, articulates with atlas. Unlike atlas, axis does include all the typical vertebral features. Its transverse processes also include transverse foramina (as do all cervical vertebrae). On the superior surface of the body is the **dens**, also called the odontoid process, which fits into the anterior arch of atlas and allows us to rotate our head from side to side as if nodding "no". Note that because atlas lacks a body, there is no intervertebral disc between atlas and axis.

Activity:

1. Be able to identify atlas and axis and distinguish them from other cervical vertebrae.
2. Identify the following bony features of atlas:

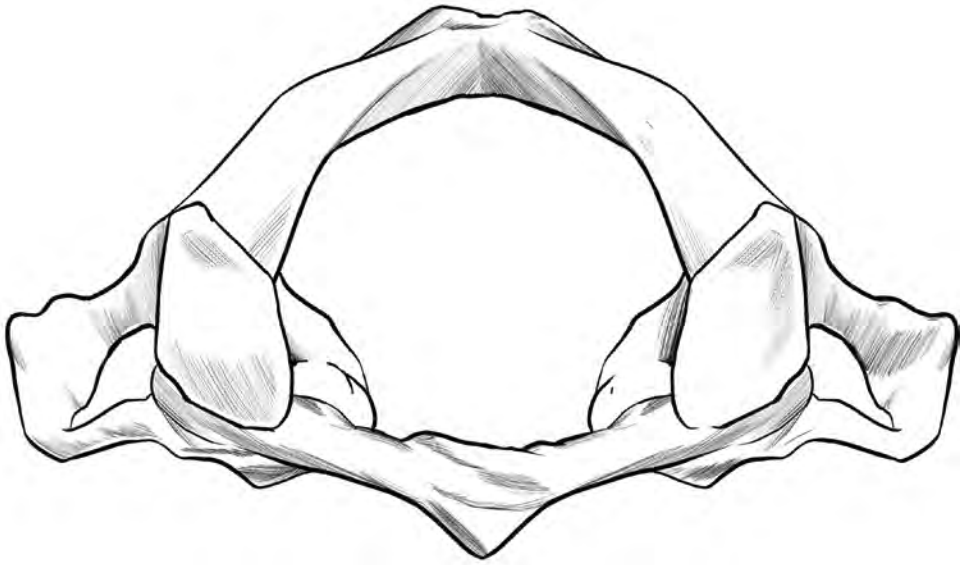
☐	Anterior arch	☐	Transverse foramen
☐	Posterior arch	☐	Transverse process
☐	Superior articular facet	☐	Vertebral foramen

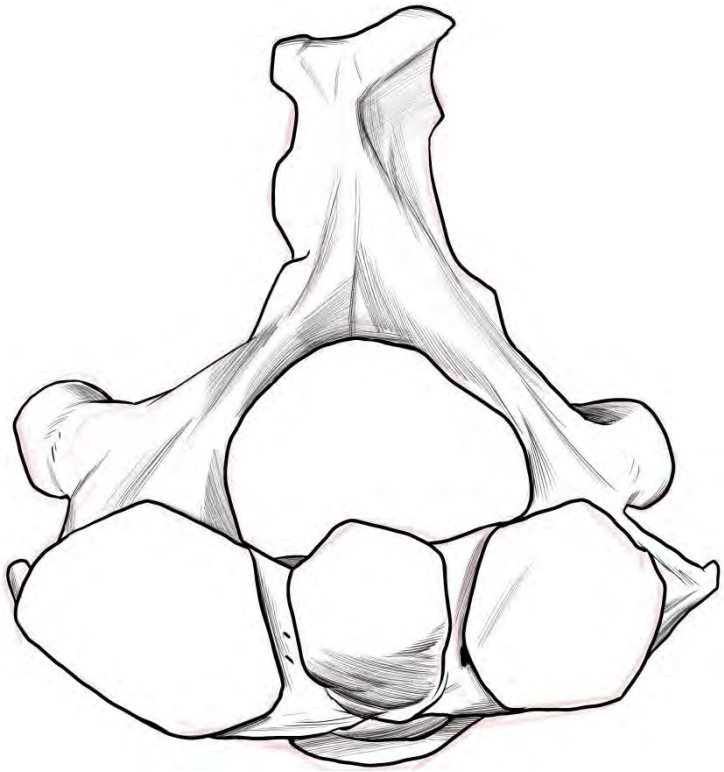
3. Identify the following bony features of axis:

☐	Body	☐	Superior articular facet
☐	Dens	☐	Transverse process
☐	Spinous process	☐	Vertebral foramen

Atlas and Axis

(Superior View)





Cervical Vertebra
(Superior View)

This image is showing the typical structure of the remaining **cervical vertebrae** (C3-C7). They have all the typical regions of the vertebra, including a body, and transverse and spinal processes.

Recall that the cervical vertebrae are the smallest of all the vertebrae because they bear the least weight. There are some other distinguishing features. The **spinous processes** of C3-C6, which are short, are **bifurcated** as a result of muscles of the neck pulling the bone into a V shape. The vertebral foramen is large to fit the spinal cord, which is still wide at this point. As we saw with atlas and axis, the **transverse processes** all contain **transverse foramina** to accommodate the vertebral arteries that supply the brain.

C7 has a particularly long, non-bifid, spinous process, which can be felt; it is referred to as the **vertebra prominens**.

Activity:

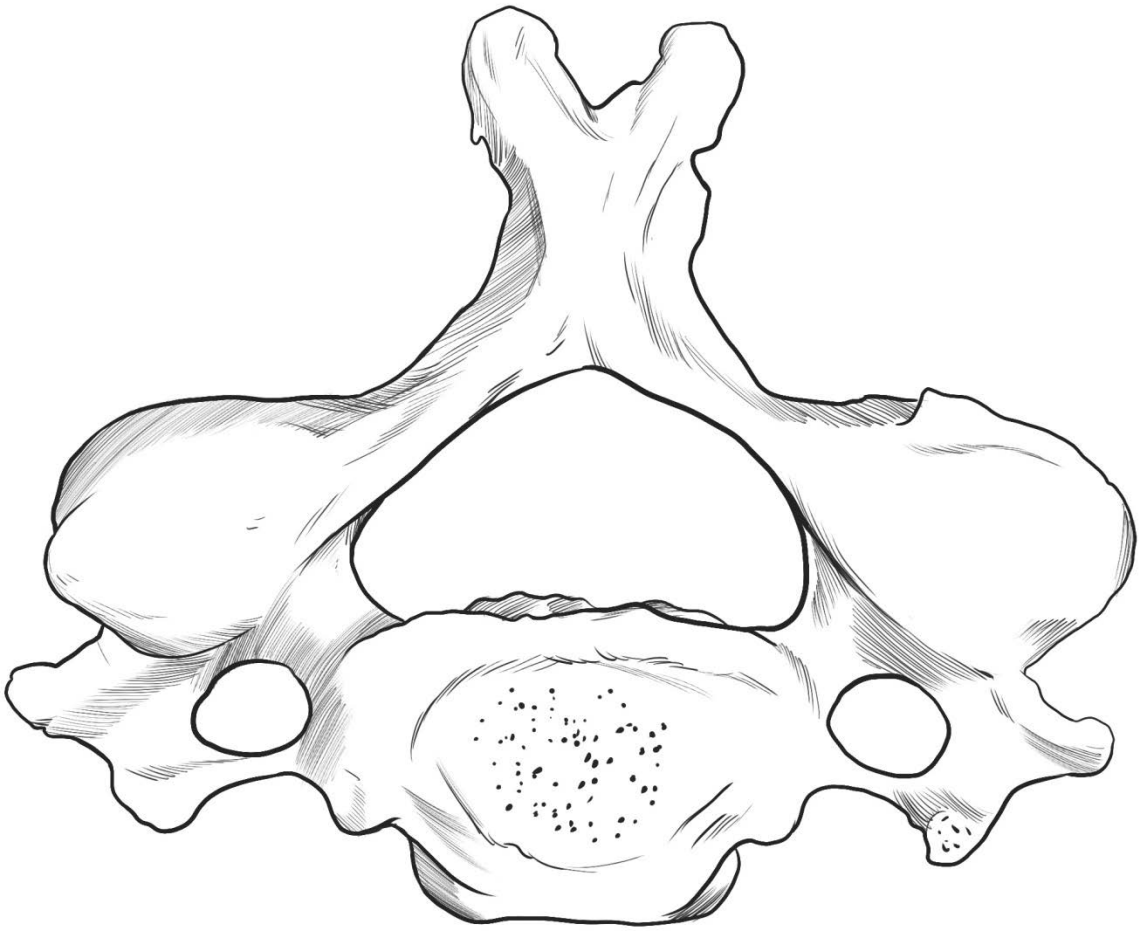
1. Be able to distinguish cervical vertebrae from thoracic and lumbar.
2. Identify the following features:

☐	Bifid spinous process	☐	Transverse foramen
☐	Body	☐	Transverse process
☐	Superior articular facet	☐	Vertebral foramen

3. Which vertebra is considered vertebra prominens, and why?

Cervical Vertebra

(Superior View)



Thoracic Vertebra
(Superior and Lateral Views)

There are twelve **thoracic vertebrae**, numbered T1-T12. Thoracic vertebrae have all the features of a typical vertebra: **body**, **pedicles**, **transverse processes**, **laminae**, and a **spinous process** surrounding a **vertebral foramen**. The spinous process is long, and points downward. Note that the spinal cord is getting progressively smaller and the vertebral foramen is also getting progressively smaller. **Superior and inferior articular facets** allow the thoracic vertebrae to articulate with the vertebrae above and below them.

Thoracic vertebrae articulate with the ribs, and therefore have structural modifications to accommodate that purpose. On the lateral side of the body, you can see **superior and inferior costal facets.** These tiny facets allow the thoracic vertebrae to articulate with the head of the rib. The transverse processes of T1-T10 also have **transverse costal facets**, which articulate with the tubercle of the rib.

Activity:

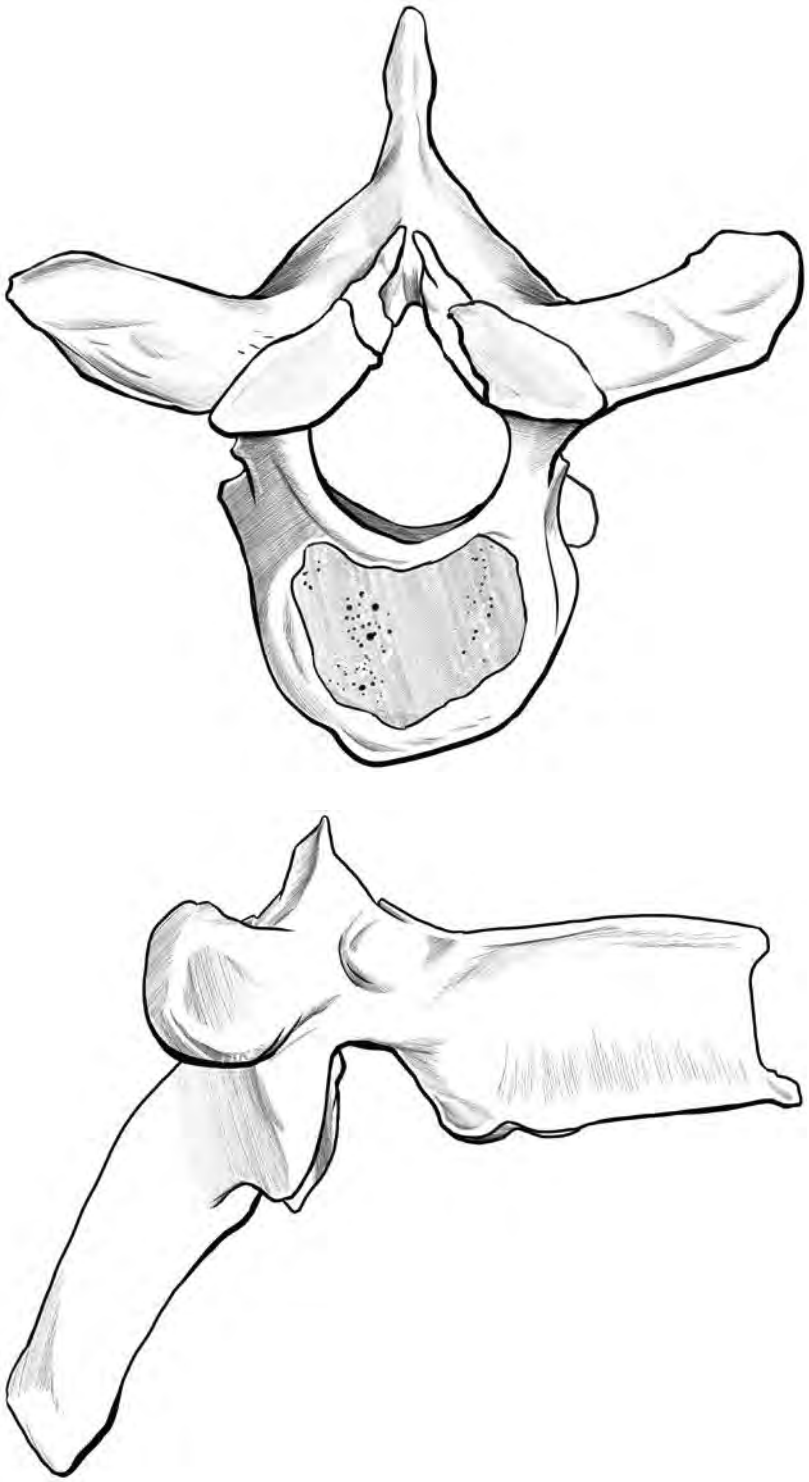
1. Be able to distinguish thoracic vertebrae from cervical and lumbar.
2. Identify the following bony features:

☐	Body	☐	Superior costal facet
☐	Inferior costal facet	☐	Transverse costal facet
☐	Spinous process	☐	Transverse process
☐	Superior articular facet	☐	Vertebral foramen

3. What bones articulate with the costal facets?
4. What bones articulate with the articular facets?

Thoracic Vertebra

(Superior and Lateral Views)



Lumbar Vertebra
(Superior View)

There are five **lumbar vertebrae** in the lower back, numbered L1-L5. These are the largest of all the vertebrae because they bear the most weight. They include all the features of a typical vertebra. The **body** is large. The **transverse processes** are short and point straight to the side. The **spinous process** is short, thick, and straight. The **vertebral foramen** is small and triangle-shaped.

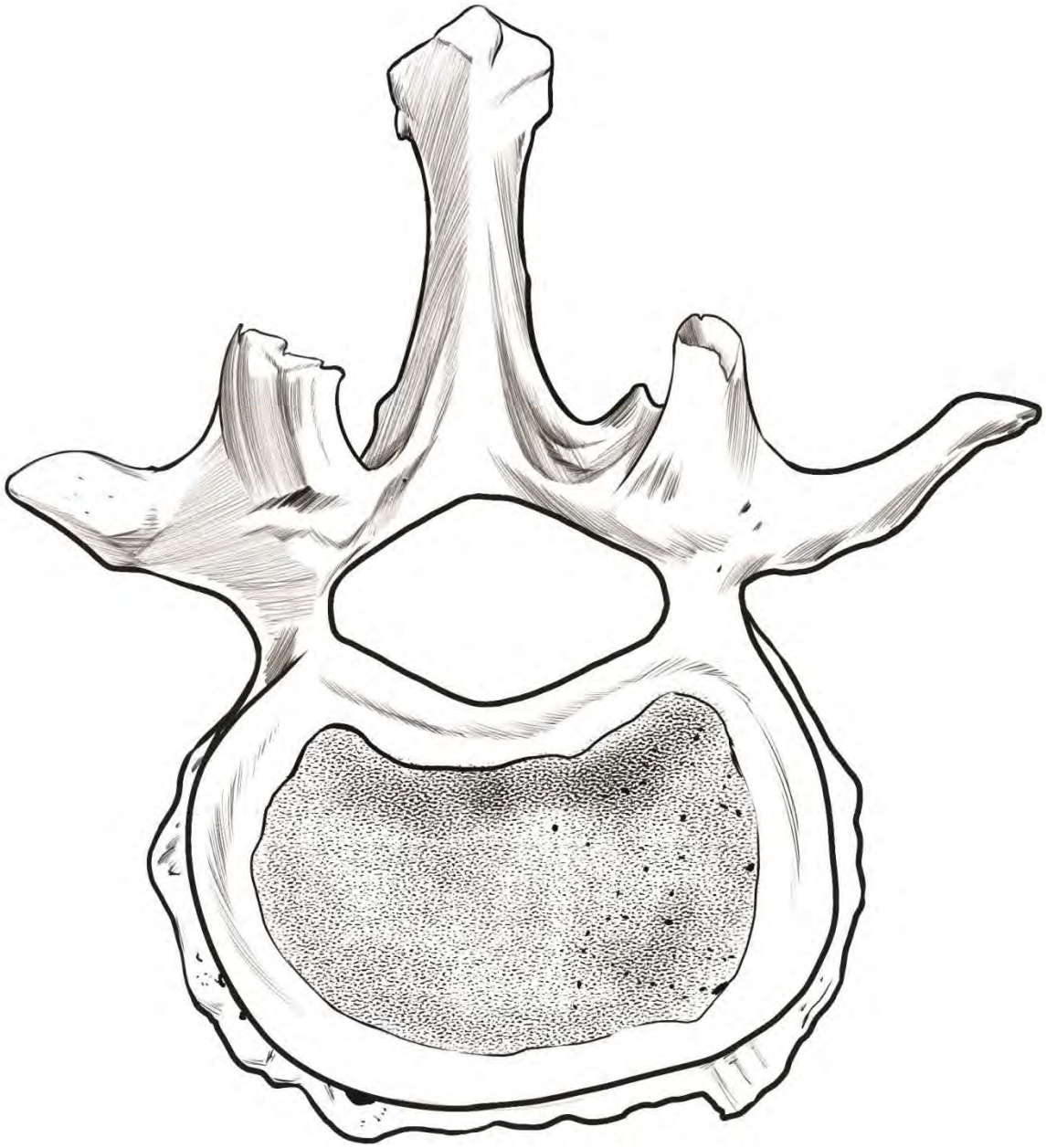
Activity:

1. Be able to distinguish lumbar vertebrae from cervical and thoracic.
2. Identify the following bony features:

- ☐ Body
- ☐ Transverse process
- ☐ Spinous process
- ☐ Vertebral foramen
- ☐ Superior articular facet

Lumbar Vertebra

(Superior View)



Sacrum and Coccyx
(Anterior View)

The **sacrum** is created as a result of the fusion of five vertebrae; these vertebrae fuse by the time you are about 30 years old. The sacrum articulates with the fifth lumbar vertebra superiorly and the coccyx inferiorly. Laterally, the sacrum articulates with the two coxal bones (hip bones, to be discussed shortly). It forms the posterior wall of the pelvis. On the superior surface are **superior articular processes**, which articulate with the inferior articular processes of the fifth lumbar vertebra. There are four pairs of holes, called **sacral foramina**, through which nerves pass.

The **coccyx**, often referred to as the tail bone, is the most inferior region of the vertebral column. Three to five vertebrae, which may or may not fuse together, form the coccyx. All vertebrate embryos have a tail during the very early stages of development. As differentiation occurs, humans' tails degenerate and all that remains is the coccyx. It serves no practical purpose, other than to provide at attachment site for a ligament called the filum terminale which holds the spinal cord in place.

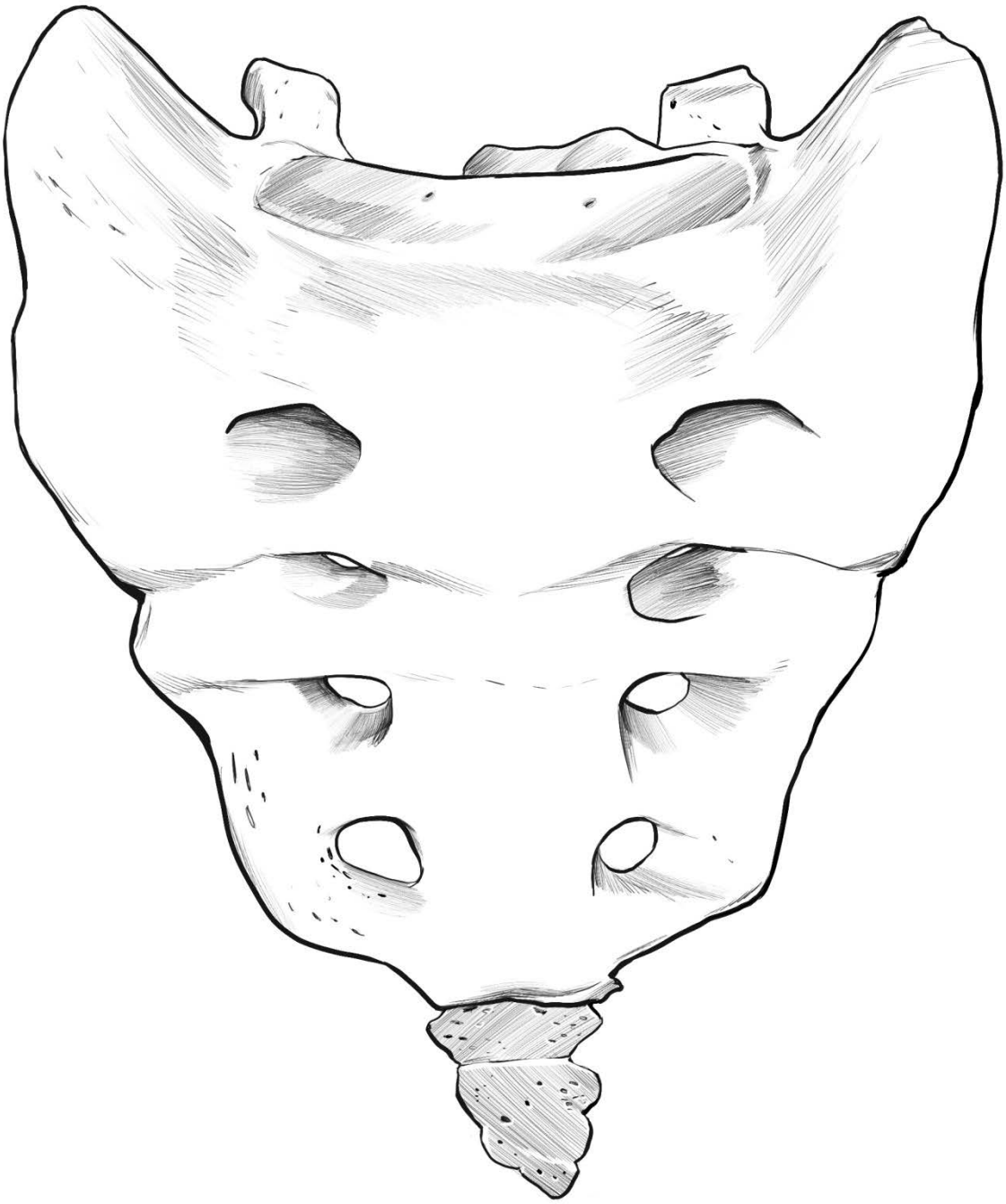
Activity:

1. Identify the following bony features:

☐	Coccyx	☐	Sacrum
☐	Sacral foramina	☐	Superior articular processes

Sacrum and Coccyx

(Anterior View)



The Thoracic Cage
(Anterior View)

The heart and lungs are protected within the **thoracic cage**, colloquially referred to as the rib cage. It is composed of bone and cartilage. Anteriorly, it is formed by the **sternum**. Posteriorly, it includes the twelve **thoracic vertebrae**. Between the vertebrae and the sternum are twelve pairs of **ribs** and **costal cartilage**. The costal cartilage, composed of hyaline cartilage, gives the thoracic cage flexibility to change volume during breathing. The ribs are numbered 1-12. The first 7 ribs are considered **true ribs**; the costal cartilage of these ribs attach directly to the sternum. Ribs 8-12 are considered **false ribs**; either their costal cartilage attaches to the sternum indirectly, or the ribs lack costal cartilage and an anterior attachment point altogether. Ribs 11 and 12 fall into that last category; therefore they are also referred to as **floating ribs**. The **costal margin**, the lower edge of the thoracic cage, is created by the costal cartilages of ribs 7-10. This margin can be felt.

Activity:

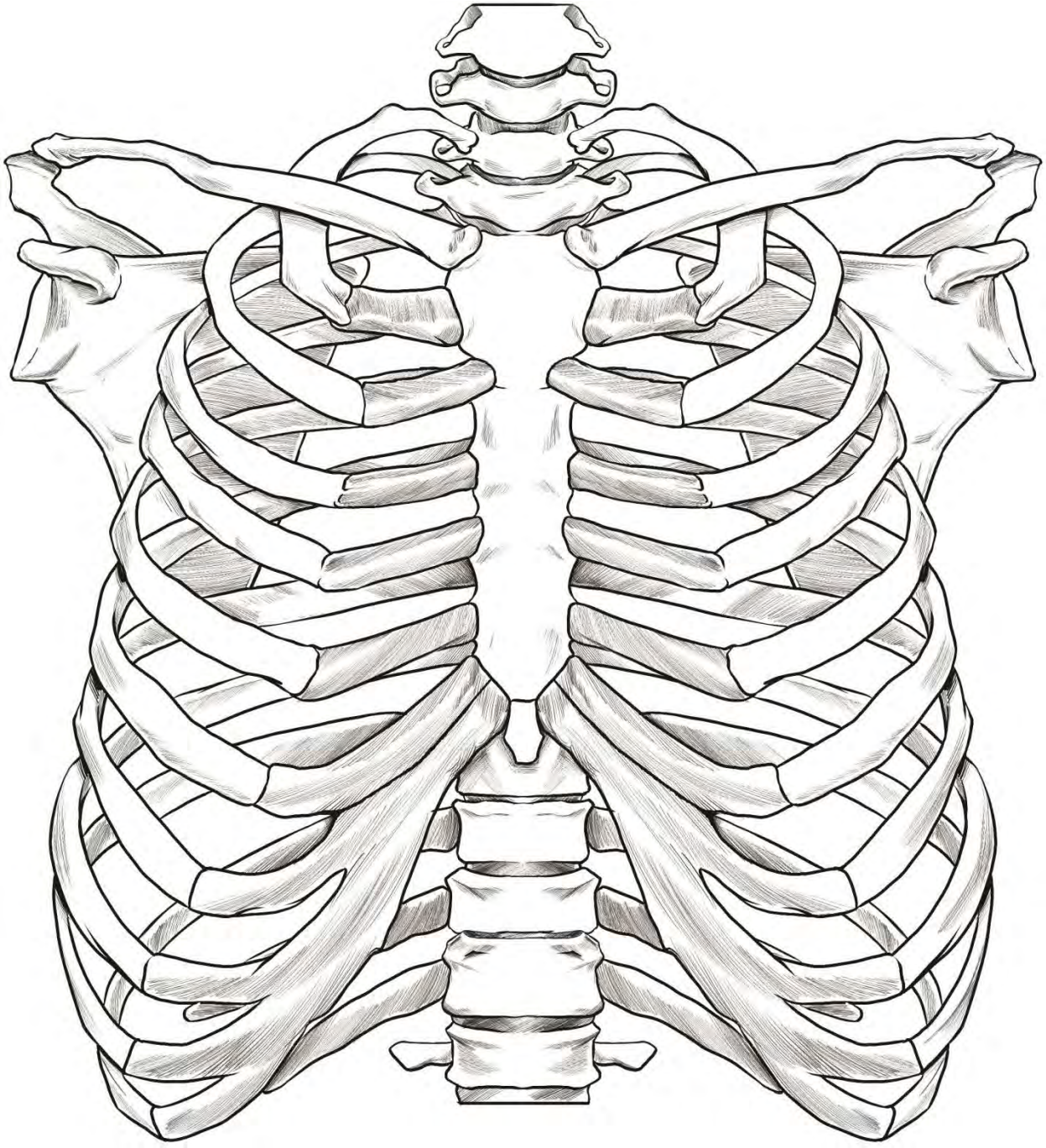
1. Identify the following structures:

☐	Costal cartilage	☐	Sternum
☐	Costal margin	☐	Thoracic vertebrae
☐	False ribs	☐	True ribs
☐	Floating ribs		

2. Why doesn't the bone of the rib attach directly to the sternum?
3. How many true ribs are there?
4. How many false ribs are there?
5. What makes a rib "true" versus "false"?
6. How many floating ribs are there?
7. What makes a rib a "floating" rib?

The Thoracic Cage

(Anterior View)



The Rib
(Posterior View)

Recall that the **rib** articulates with the thoracic vertebrae posteriorly and the sternum via costal cartilage anteriorly (except for ribs 11 and 12, the floating ribs, which have no anterior attachment point). The **head** of the rib articulates with the superior and inferior costal facets of the body of the thoracic vertebrae, at the junction point where two vertebrae stack on top of one another. There are two small **articular facets**, one that articulates with the superior vertebra, and the other that articulates with the inferior vertebra. Just past the head is the **neck**. After the neck there is a small protuberance called the **tubercle**, which articulates with the transverse process of the vertebrae. The **shaft** of the rib forms a sharp angle as it curves around from the posterior of the thorax to the anterior. There is a groove on the inferior portion of the shaft, called the **costal groove**, through which nerves and vessels run. The sternal end of the rib is flat, and provides an attachment site for costal cartilage.

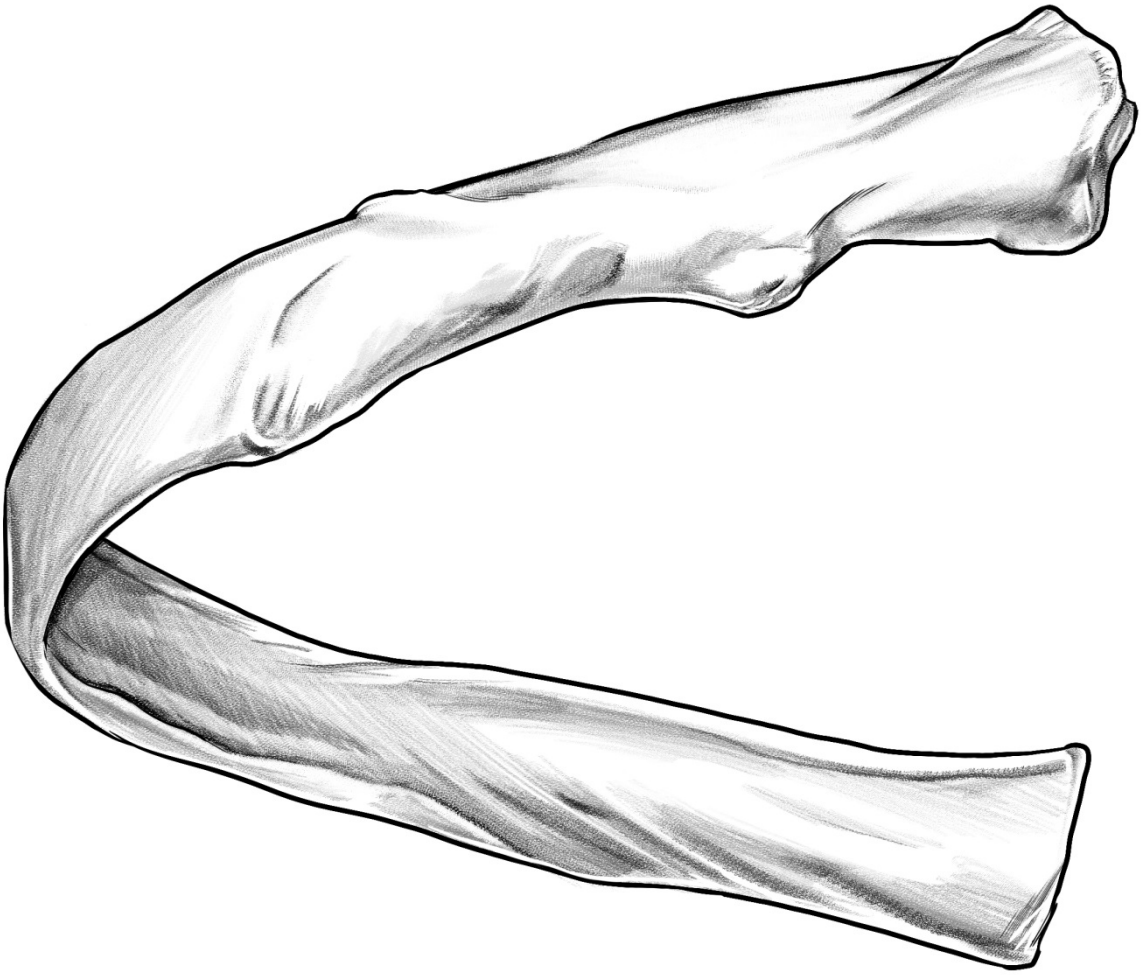
Activity:

1. Identify the following bony features:

☐	Articular facets	☐	Neck
☐	Costal groove	☐	Shaft
☐	Head	☐	Tubercle

2. Be able to distinguish right from left.

The Rib
(Posterior View)



The Sternum
(Anterior View)

The **sternum** is commonly referred to as the breast bone. It is found in the center of the anterior side of the thoracic cage, and protects the heart. There are three sections to the sternum. The superior-most region is the **manubrium**, which is shaped like a quadrangle. It articulates with the clavicles at the right and left **clavicular notches**, which are located near the top of the manubrium. It also articulates with the first costal cartilage at its base. At the top of the manubrium is another notch, called the **jugular notch** (also called suprasternal notch). This landmark can easily be felt. At its base, the manubrium has a ridge called the **sternal angle**, which is created when the manubrium connects to the **body**. The costal cartilage of the second rib joins at the sternal angle as well. The body extends from the second rib to about the fifth rib. It articulates with the remaining costal cartilages. At its distal end, it forms the xiphisternal joint with the **xiphoid process**, the final region of the sternum. This part of the sternum is shaped like an arrow-head, and remains in its cartilage state until about 40 years of age.

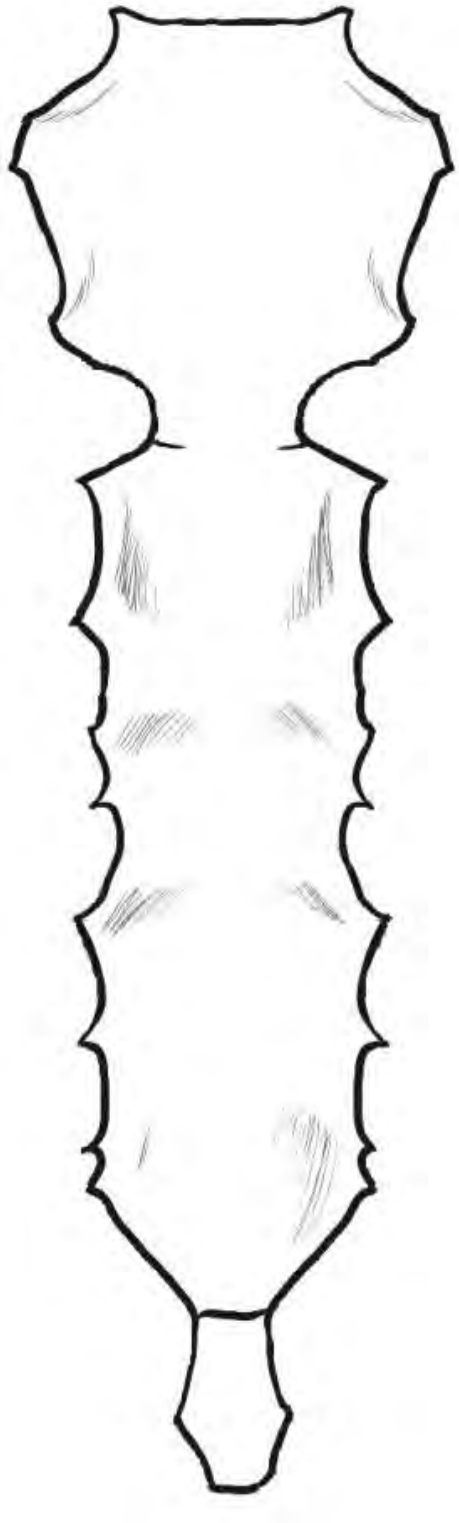
Activity:

1. Identify the following features:

☐	Body	☐	Manubrium
☐	Clavicular notches	☐	Sternal angle
☐	Jugular notch	☐	Xiphoid process

The Sternum

(Anterior View)



The Clavicle
(Superior and Inferior Views)

The appendicular skeleton includes all of the bones that form the upper and lower appendages. The upper appendage begins at the pectoral girdle (the shoulder), which includes the clavicle and the scapula.

The **clavicle** is commonly referred to as the collarbone. It is an S-shaped bone that attaches the upper limb to the trunk. The **sternal end** attaches medially to the manubrium of the sternum. The **acromial end** attaches laterally to the acromion of the scapula. The superior surface of the clavicle is smooth, but the inferior surface has the **conoid tubercle**, a cone-shaped attachment site for the conoid ligament.

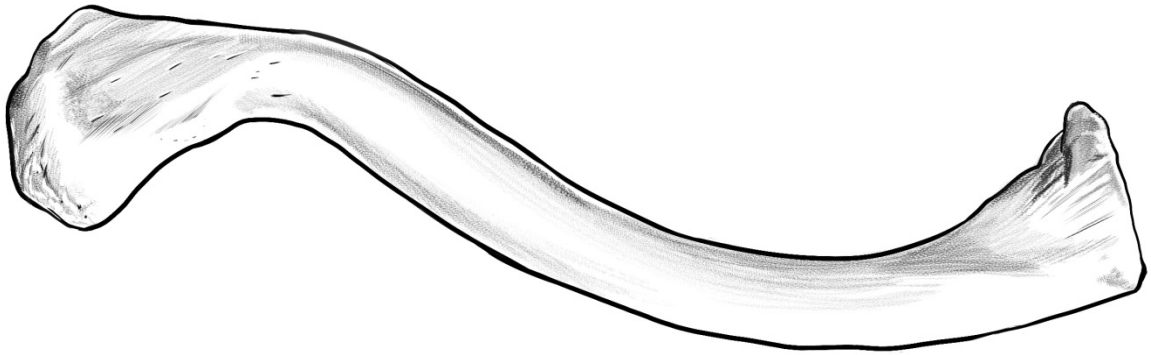
Activity:

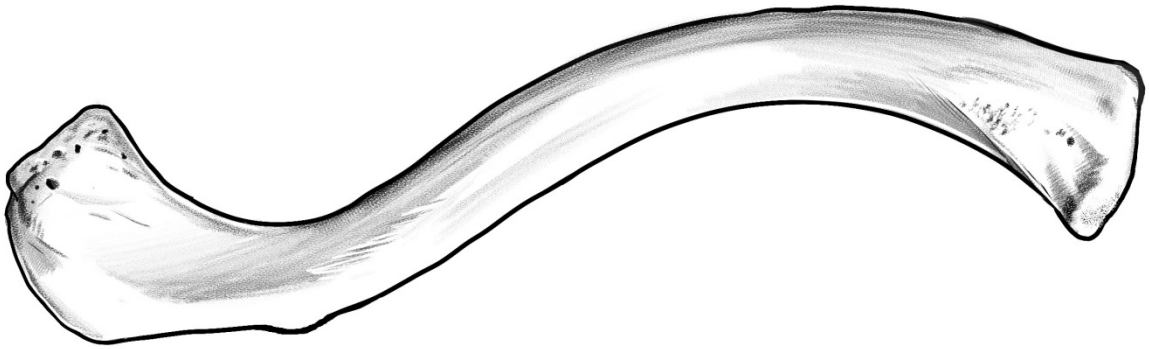
1. Identify the following bony features:

- ☐ Acromial end
- ☐ Conoid tubercle
- ☐ Sternal end

2. Be able to distinguish right from left.

The Clavicle
(Superior and Inferior Views)





The Scapula
(Anterior View)

The scapula is the second bone that is part of the pectoral girdle. This triangle-shaped bone is often referred to as the shoulder blade. The three borders of the scapula are the **superior border**, **lateral (axillary) border**, and **medial (vertebral) border**. The inferior most portion of the scapula comes to a point at the **inferior angle**. Several bony features of the scapula can also be seen. Near the lateral side of the superior border is the **coracoid process**, which is an attachment site for muscles. Behind the coracoid process is another prominence, called the **acromion**, which articulates with the clavicle. On the superior-most portion of the lateral border is the **glenoid cavity**, which articulates with the humerus. A large fossa is found on the anterior surface of the scapula, called the **subscapular fossa**; a muscle attaches here.

Activity:

1. Identify the following bony features:

☐	Acromion	☐	Lateral border
☐	Coracoid process	☐	Medial border
☐	Glenoid cavity	☐	Subscapular fossa
☐	Inferior angle	☐	Superior border

2. Be able to distinguish right from left.

The Scapula
(Anterior View)

The Scapula
(Posterior View)

From the posterior view, the **superior, lateral and medial borders** can be seen, as well as the **inferior angle**. A prominent **spine** is seen, which runs from the medial border, toward the lateral border and beyond the **glenoid cavity** to end at the lateral projection called the **acromion**; the acromion articulates with the clavicle. Above the spine is a small fossa called the **supraspinous fossa**, and below the spine is the larger **infraspinous fossa**; both fossae contain muscles.

<u>Activity:</u>

1. Identify the following bony features:

- ☐ Acromion
- ☐ Glenoid cavity
- ☐ Inferior angle
- ☐ Infraspinous fossa
- ☐ Lateral border
- ☐ Medial border
- ☐ Spine
- ☐ Supraspinous fossa
- ☐ Superior border

The Scapula
(Posterior View)

The Humerus
(Anterior and Posterior Views)

The **humerus** is the arm bone. It articulates with the scapula at the pectoral girdle and the radius and ulna at the elbow.

At the proximal end of the humerus is the **head**, which articulates with the glenoid cavity of the scapula. Just distal to the head is the **anatomical neck**. Distal to that are the **greater and lesser tubercles**; the greater tubercle is larger than, and more superior to, the lesser tubercle. Both provide attachment sites for muscles. In between the tubercles is a groove called the **intertubercular sulcus**. The **surgical neck**, where the humerus is most often fractured, is distal to the tubercles.

The shaft of the humerus is fairly smooth, except mid-shaft on the lateral surface there is a **deltoid tuberosity**, named after the muscle that attaches to it.

At the proximal end of the humerus, the **trochlea**, on the medial side, articulates with the ulna. The **capitulum**, on the lateral side, articulates with the radius. Above these two condyles are two epicondyles: the **medial epicondyle** and the **lateral epicondyle**. These two features provide attachment sites for muscles. On the anterior surface there is a small **coronoid fossa**, in which a portion of the ulna fits. On the posterior surface is a much larger **olecranon fossa**, also in which a feature of the ulna fits.

Activity:

1. Identify the following bony features:

☐ Anatomical neck	☐ Head	☐ Medial epicondyle
☐ Capitulum	☐ Intertubercular sulcus	☐ Olecranon fossa
☐ Coronoid process	☐ Lateral epicondyle	☐ Surgical neck
☐ Deltoid tuberosity	☐ Lesser tubercle	☐ Trochlea
☐ Greater tubercle		

2. Be able to distinguish right from left.

The Humerus

(Anterior and Posterior Views)

The Ulna
(Anterior and Posterior Views)

The **ulna** is one of two bones that form the forearm. It is the longer of the two bones, and is located on the medial side of the forearm. The ulna articulates with the humerus at the elbow and the carpals at the wrist.

The ulna has a hook-like structure on its proximal end. The most superior region of the ulna is the **olecranon process**, which articulates with the olecranon fossa on the posterior surface of the humerus. Distal to that is the **trochlear notch**, in which the trochlea of the humerus sits. The notch ends in the **coronoid process**, which fits into the coronoid fossa on the anterior surface of the humerus. On the lateral side, near the coronoid process is the **radial notch**, which articulates with the radius at the proximal radioulnar joint.

The **head** of the ulna is located on the distal end of the ulna. The head articulates with the radius at the distal radioulnar joint. The distal end of the ulna comes to a point at the **styloid process**, which is an attachment site for a ligament. The ulna and carpals are not actually touching; they are separated by connective tissue. Therefore, the ulna is more important in the functioning of the elbow, rather than the wrist.

Activity:

1. Identify the following bony features:

☐	Coronoid process	☐	Radial notch
☐	Head	☐	Styloid process
☐	Olecranon process	☐	Trochlear notch

2. Be able to distinguish right from left.

The Ulna

(Anterior and Posterior Views)

The Radius
(Anterior and Posterior Views)

The **radius** is the second of the two bones of the forearm. It is shorter than the ulna and is located on the lateral portion of the forearm. Proximally it articulates with the humerus at the elbow and distally it articulates with the carpals at the wrist.

The **head** of the radius is located on the proximal end. It is shaped like a disc, with a concave portion on the top; the capitulum of the humerus sits in the head. The head also articulates with the ulna; the medial side of the head fits into the radial notch of the ulna. Distal to the head, is the **neck**. Distal to the neck, on the anterior surface, is the **radial tuberosity**; this is an attachment site for a muscle.

The distal end of the radius, which articulates with the head of the ulna at the distal radioulnar joint, comes to a point at the **styloid process**; this is an attachment site for a ligament. The radius articulates with the carpals at the distal end. Unlike the ulna, which was an important component of the elbow, the radius is more important in the functioning of the wrist.

Activity:

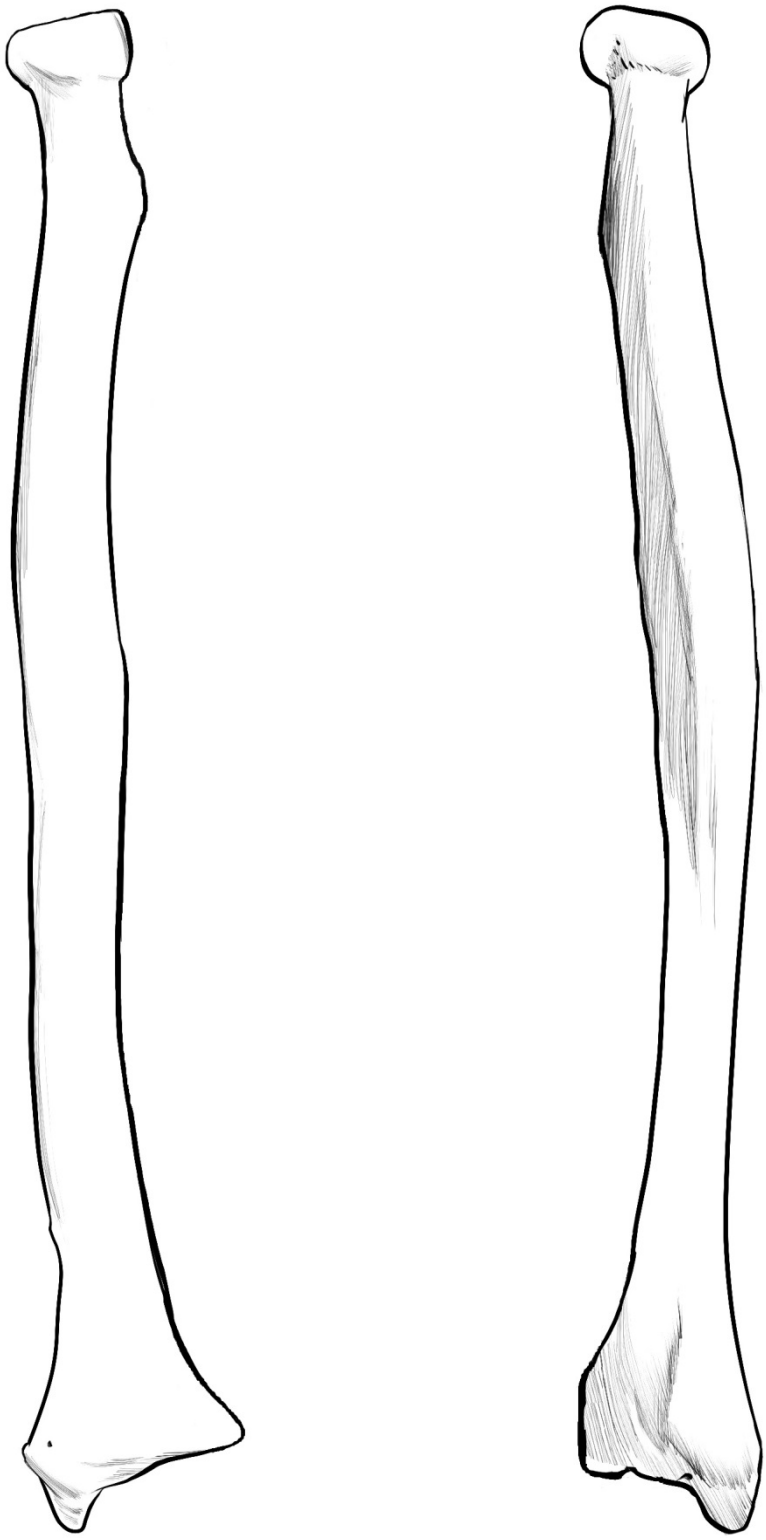
1. Identify the following bony features:

☐	Head	☐	Radial tuberosity
☐	Neck	☐	Styloid process

2. Be able to distinguish right from left.

The Radius

(Anterior and Posterior Views)



The Hand
(Anterior View)

The hand is composed of carpal bones (forming the wrist), metacarpals (forming the palm) and phalanges (forming the digits). There are eight **carpal** bones; the anterior view is ideal for viewing all eight. There are two rows of four bones. Beginning with the proximal row, and naming from lateral to medial, there are the: **scaphoid**, **lunate**, **triquetrum** and **pisiform**. In the distal row, again naming from lateral to medial, there are: **trapezium**, **trapezoid**, **capitate** and **hamate**. The metacarpals are much easier to remember. There are five **metacarpals** – one for each digit – and they are numbered 1-5, from lateral (thumb side) to medial (pinky side). There are fourteen total phalanges, the bones that form the digits. Digits 2-5 have **proximal, middle and distal phalanges**; digit 1 (the thumb) only has proximal and distal phalanges.

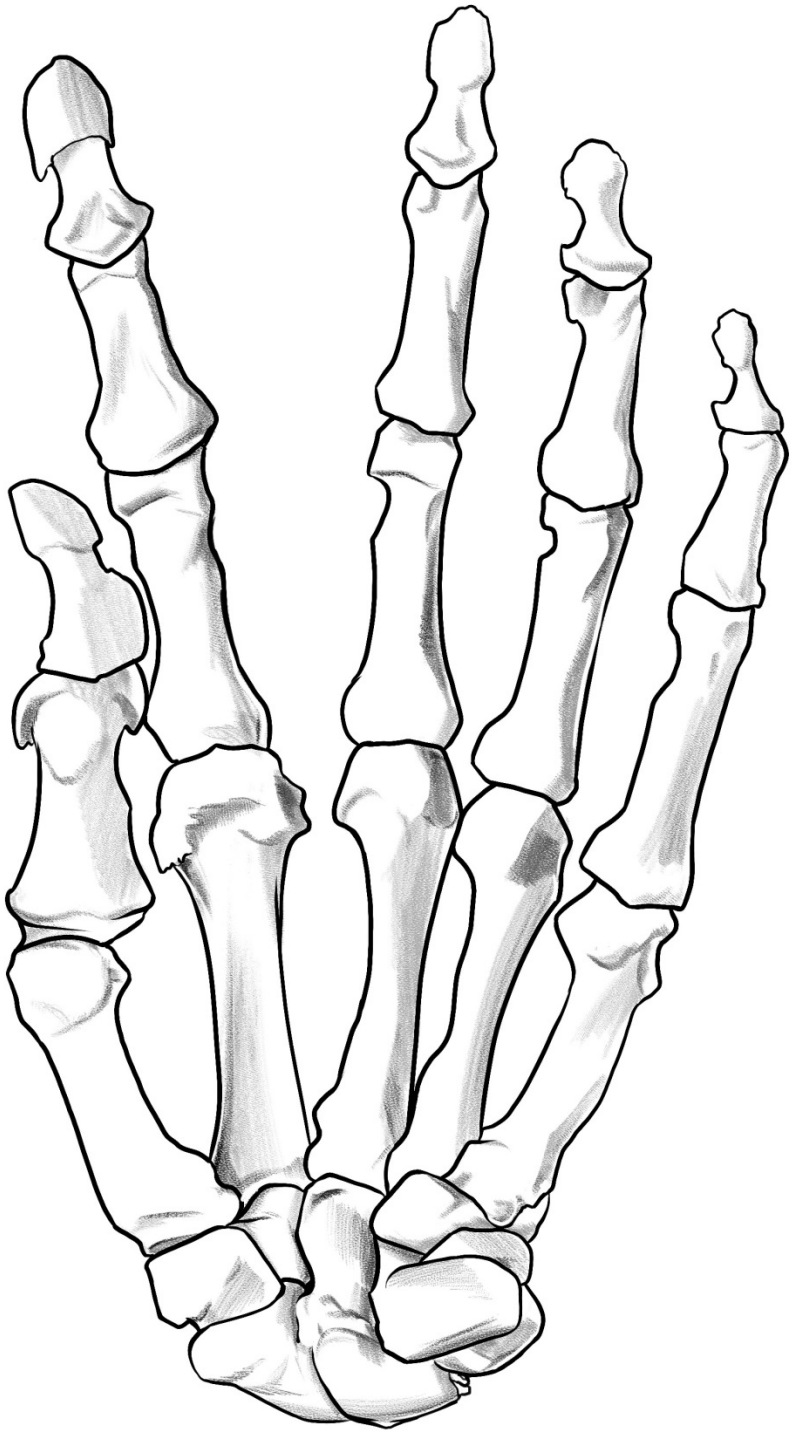
Activity:

1. Identify the following bones:

☐	Capitate	☐	Pisiform
☐	Distal phalanges	☐	Proximal phalanges
☐	Hamate	☐	Scaphoid
☐	Lunate	☐	Trapezium
☐	Metacarpals	☐	Trapezoid
☐	Middle phalanges	☐	Triquetrum

Mnemonic for the carpals:
Sally Left The Party To Take Cathy Home

The Hand
(Anterior View)



The Coxal Bone
(Lateral View)

The lower appendage begins at the pelvic girdle (the pelvis), which includes the **coxal bones** and the sacrum. The coxal bones, which are created by the fusion of three separate bones, attach the lower limb to the trunk. The three bones come together to form the **acetabulum**, a large cavity on the lateral side of the coxal bones, which forms the socket of the ball-and-socket joint of the hip.

The largest and most superior of the coxal bones is the **ilium**. The superior portion of the ilium forms the **iliac crest**, which is an attachment site for muscles. Anteriorly, the crest leads to two projections: the **anterior superior iliac spine** and the **anterior inferior iliac spine**. Posteriorly, the crest leads to two more projections: the **posterior superior iliac spine** and the **posterior inferior iliac spine**. These projections provide attachment sites for muscles and ligaments. Beneath the posterior inferior iliac spine is a groove, called the **greater sciatic notch**; muscles, nerves and blood vessels run through this notch. The ilium forms a little less than 40% of the acetabulum on its upper boundary.

The **ischial spine** of the ischium is found just underneath the greater sciatic notch. It is an attachment site for a ligament. Just beneath the spine is a small groove, called the **lesser sciatic notch**; nerves and blood vessels run through this notch. There is a prominent **ischial tuberosity** on the most inferior portion of the coxal bones. We sit on the ischial tuberosity, and a ligament also attaches here. The ischium forms a little more than 40% of the acetabulum on its inferior/posterior boundary.

The third bone is the **pubis**. Its features will be discussed shortly. The pubis forms less than 20% of the acetabulum on its inferior/anterior boundary.

Beneath the acetabulum is a large hole – the **obturator foramen** – through which nerves and blood vessels pass. It is formed by the ischium posteriorly and pubis anteriorly.

Activity:

1. Identify the following bony features:

☐ Acetabulum	☐ Iliac crest	☐ Obturator foramen
☐ Anterior inferior iliac spine	☐ Ischial spine	☐ Posterior inferior iliac spine
☐ Anterior superior iliac spine	☐ Ischial tuberosity	☐ Posterior superior iliac spine
☐ Greater sciatic notch	☐ Lesser sciatic notch	

2. Label the borders of the ilium, ischium and pubis.

The Coxal Bone

(Lateral View)

The Coxal Bone
(Medial View)

Many of the same features of the ilium and ischium can be seen from the medial view, including the iliac crest, iliac spines, ischial spine and the two notches. You can also observe the obturator foramen. The **iliac fossa** of the ilium, in which there is a muscle, can be seen from this perspective.

The features of the pubis are better observed on the medial portion of the bone. The **articular surface** is a flattened region of the pubis where the contralateral pubis forms the pubic symphysis joint. Just above the articular surface is the **pubic tubercle**, which provides an attachment site for a ligament. Above the tubercle is the flat **superior ramus**, which fuses to the ilium, and below it is the **inferior ramus**, which fuses to the ischium.

Activity:

1. Identify the following bony features:

☐	Anterior inferior iliac spine	☐	Inferior ramus
☐	Anterior superior iliac spine	☐	Obturator foramen
☐	Articular surface of pubis	☐	Posterior inferior iliac spine
☐	Greater sciatic notch	☐	Posterior superior iliac spine
☐	Iliac crest	☐	Pubic tubercle
☐	Iliac fossa	☐	Superior ramus

2. Be able to distinguish right from left.

The Coxal Bone

(Medial View)

The Femur
(Anterior and Posterior Views)

The **femur** is the thigh bone. It articulates with the coxal bones at the pelvic girdle and the tibia at the knee.

On the proximal end of the bone is the **head**, which articulates with the acetabulum of the coxal bone. There is a pit in the center, called the **fovea capitis**, which is an attachment site for the ligament that holds the head in the acetabulum. Distal to the head, extending laterally, is the **neck**, which is much longer in the femur than in the humerus. Similar to the greater and lesser tubercles of the humerus, the femur has **greater and lesser trochanters**. The greater trochanter is larger than, and lateral to, the lesser trochanter. Both of these features are attachment sites for muscles. In between the trochanters is the **intertrochanteric crest**. Just distal to the trochanters, on the posterior surface, is the **gluteal tuberosity**, which continues down the shaft as a line called the **linea aspera**; these features are also attachment sites for muscles.

On the distal end there are **medial and lateral condyles**; these condyles articulate with the tibia, and are best seen from the posterior view. In between the condyles, on the posterior surface, is a deep indentation called the **intercondylar fossa**. On the anterior surface, between the condyles is the **patellar surface**, where the **patella** rests. Above the condyles are **medial and lateral epicondyles**; these features are attachments sites for muscles.

Activity:

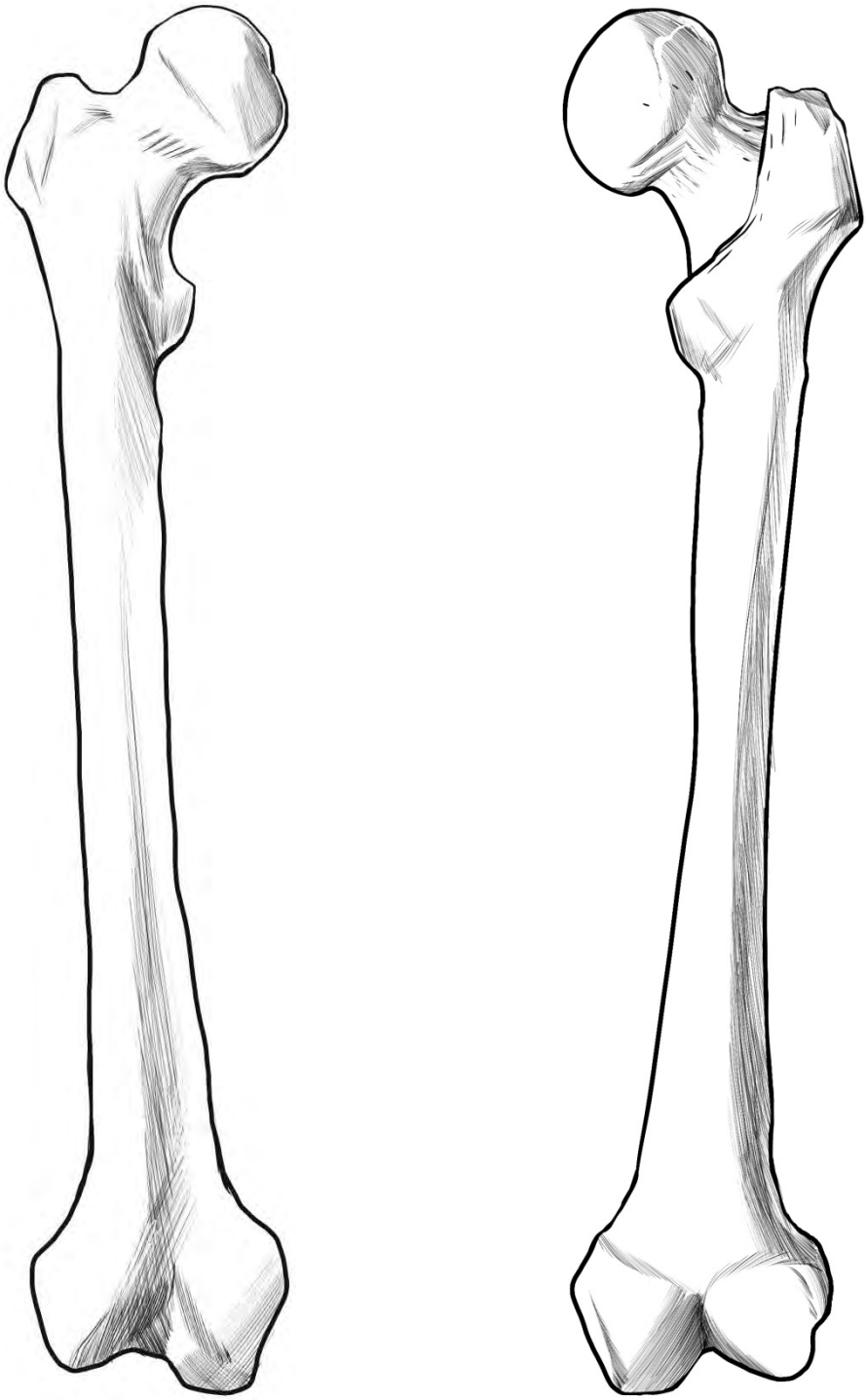
1. Identify the following features:

☐ Fovea capitis	☐ Intertrochanteric crest	☐ Medial condyle
☐ Gluteal tuberosity	☐ Lateral condyle	☐ Medial epicondyle
☐ Greater trochanter	☐ Lateral epicondyle	☐ Neck
☐ Head	☐ Lesser trochanter	☐ Patellar surface
☐ Intercondylar fossa	☐ Linea aspera	

2. Be able to distinguish right from left.

The Femur

(Anterior and Posterior Views)



The Tibia
(Anterior and Posterior Views)

The **tibia** is one of two bones that form the leg. It is the larger of the two bones, and is located on the medial side of the leg. The tibia articulates with the femur at the knee joint and the tarsals at the ankle.

On the proximal end, there **are medial and lateral condyles**, which articulate with the medial and lateral condyles of the femur. The convex condyles of the femur fit into the concave condyles of the tibia to form the knee joint. On the anterior surface, just distal to the condyles, is the **tibial tuberosity**, which is an attachment site for muscles.

On the distal end there is the **medial malleolus**. This forms the bony projection on the medial side of your ankle, and can be felt. The medial malleolus articulates with talus, one of the tarsal bones of the ankle.

Activity:

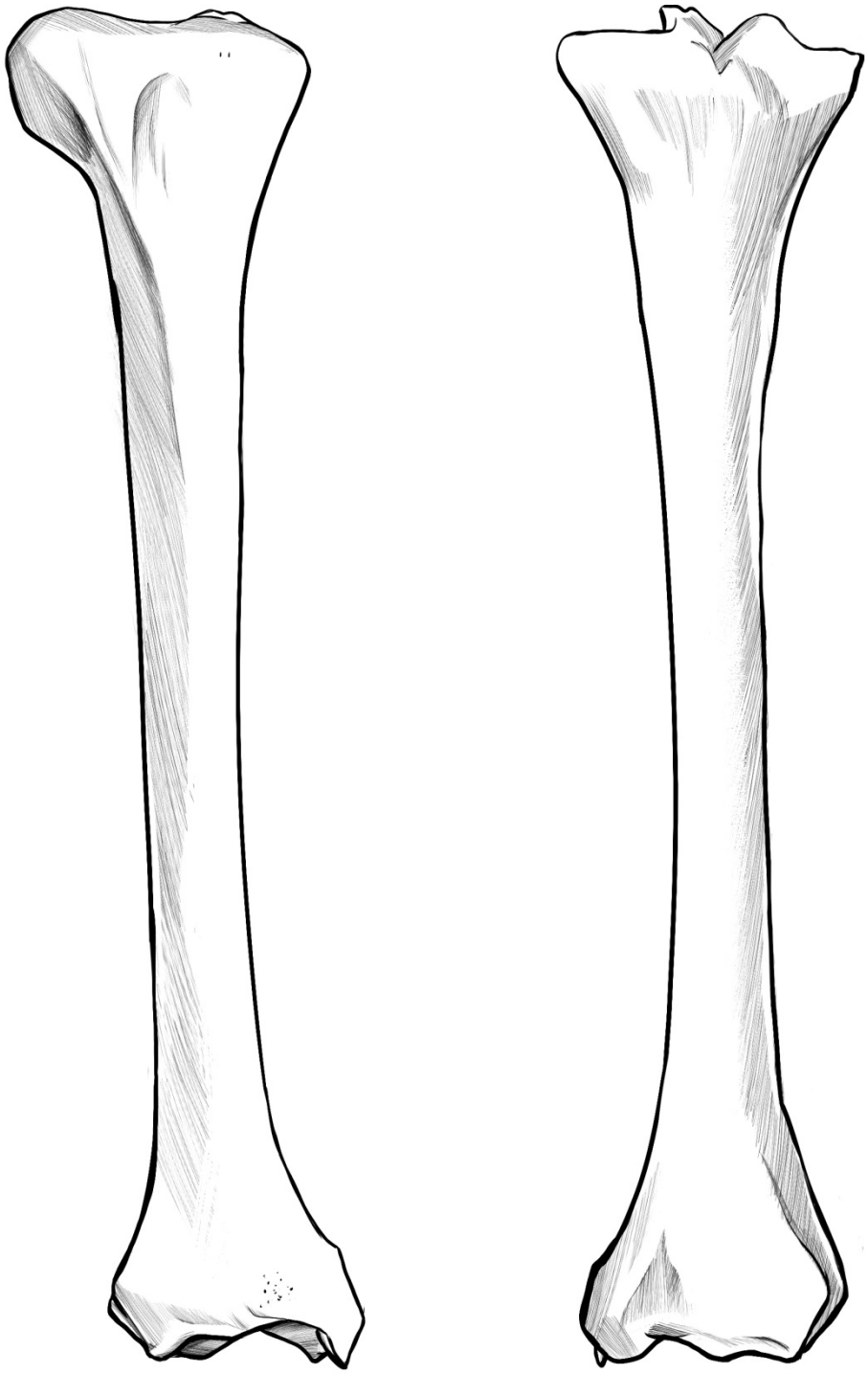
1. Identify the following bony features:

☐	Lateral condyle	☐	Medial malleolus
☐	Medial condyle	☐	Tibial tuberosity

2. Be able to distinguish right from left.

The Tibia

(Anterior and Posterior Views)



The Fibula
(Anterior and Posterior Views)

The **fibula** is the second of the two bones of the leg. It is much thinner than the tibia and it located on the lateral portion of the leg. Proximally it articulates with the tibia and distally it articulates with the tarsals at the ankle. Note that the fibula is not part of the knee joint.

The **head** of the fibula is located on the proximal side of the bone. The head articulates with the lateral side of the tibia, just distal to the lateral condyle, to form the proximal tibiofibular joint.

The **lateral malleolus** forms the distal end of the fibula. It articulates with the lateral side of the distal tibia at the distal tibiofibular joint. It also articulates with the talus at the ankle joint.

Activity:

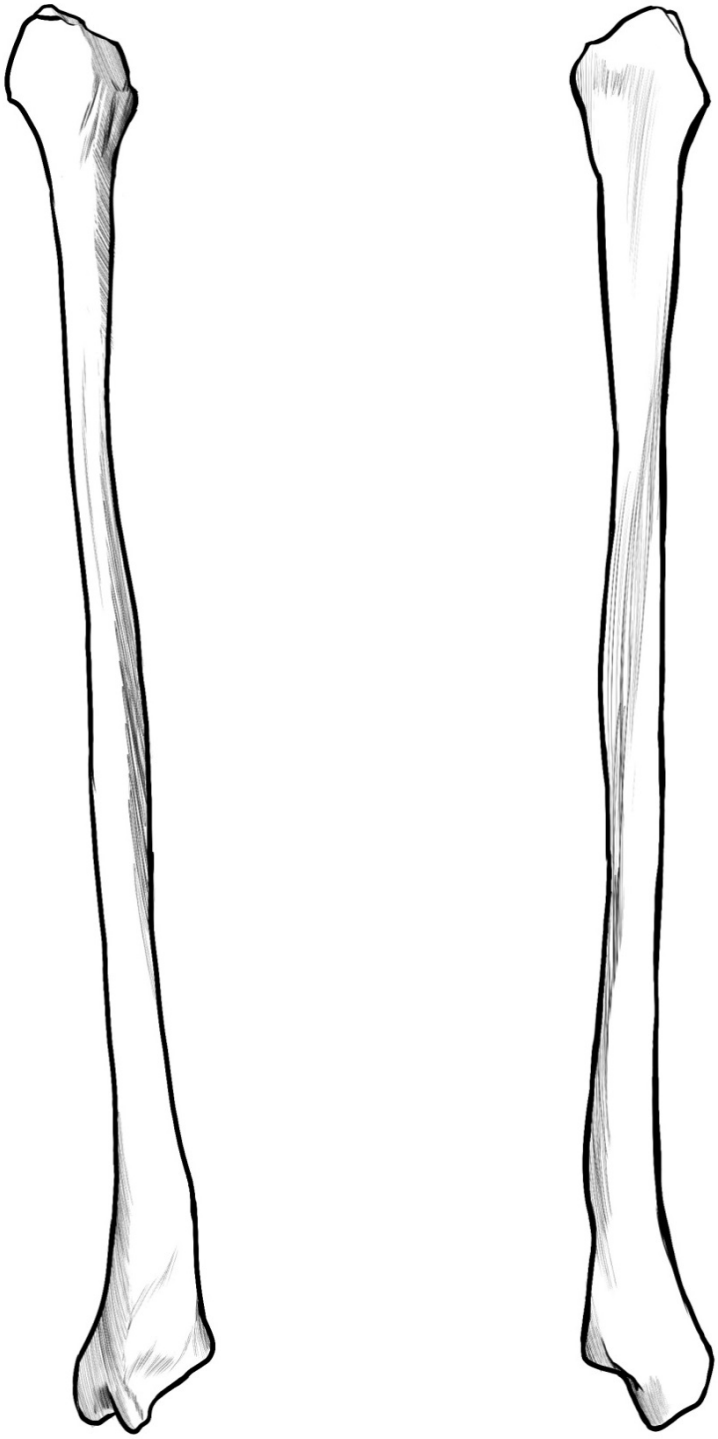
1. Identify the following bony features:

   ☐ Head ☐ Lateral malleolus

2. Be able to distinguish right from left.

The Fibula

(Anterior and Posterior Views)



The Foot
(Superior View)

The foot has a similar anatomical plan to the hand: multiple, short tarsal bones in the ankle, metatarsal bones in the in-step (metatarsus), and phalanges in the digits. There are seven **tarsal** bones. The heel is formed by the **calcaneus**; because body weight is resting on this bone, it is very large compared to the other tarsals. Resting on top of the calcaneus is the **talus**, which articulates with the tibia and fibula. Anterior to the calcaneus and talus are the five remaining bones. Right in front of the talus is the **navicular**; the remaining four tarsals are in a row, named (from lateral to medial): **cuboid**, **lateral cuneiform**, **intermediate cuneiform** and **medial cuneiform**. There are five **metatarsal** bones, numbered 1-5 from the hallux (big toe) to digit #5. Similar to the hand, there are fourteen phalanges in the digits. Digits 2-5 have **proximal, middle and distal phalanges**, and the hallux has proximal and distal phalanges.

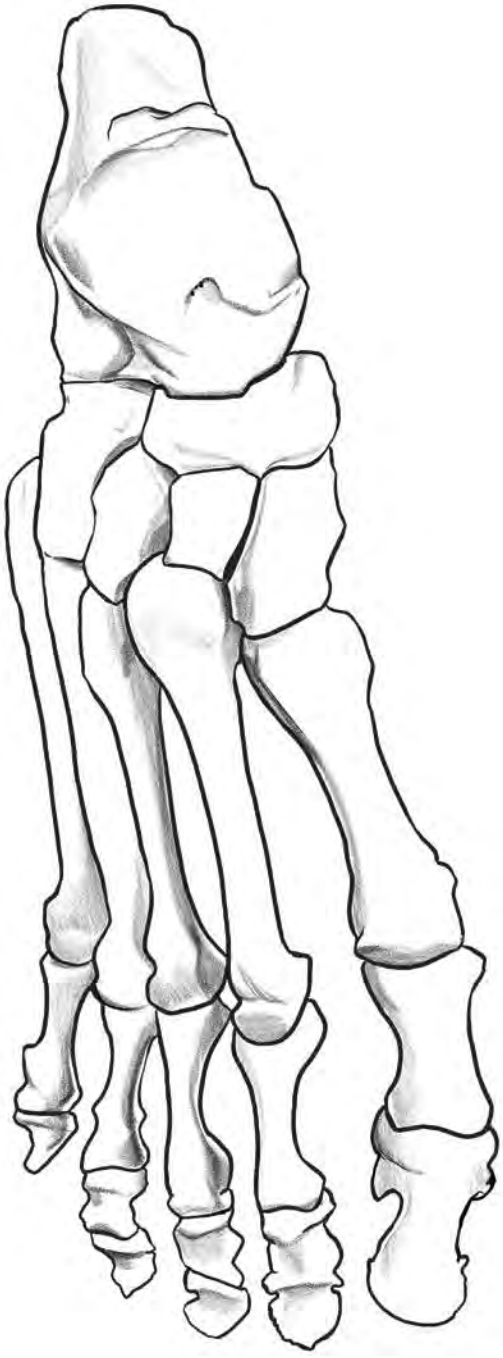
Activity:

1. Identify the following bones:

- ☐ Calcaneus
- ☐ Cuboid
- ☐ Distal phalanges
- ☐ Intermediate cuneiform
- ☐ Lateral cuneiform
- ☐ Medial cuneiform
- ☐ Metatarsals
- ☐ Middle phalanges
- ☐ Navicular
- ☐ Proximal phalanges
- ☐ Talus

The Foot

(Superior View)



Skeletal Muscle Tissue

This figure shows a section of a **myofiber**, a skeletal muscle cell. Myofibers are long, cylindrical, striated cells with multiple nuclei. Surrounding the myofiber is the plasma membrane, called the **sarcolemma**. Packed within the **sarcoplasm** (cytoplasm) are bundles of **myofilament** proteins called **myofibrils**. These organelles, which are responsible for the mechanical action of contraction, take up the majority of the space in the sarcoplasm. Surrounding the myofibrils is a network of modified endoplasmic reticulum called **sarcoplasmic reticulum**, which stores the calcium necessary for muscle contraction. Along the length of the myofibrils, the sarcoplasmic reticulum enlarges in areas called **terminal cisterns**. These swellings, which contain a large amount of calcium, are in contact with invaginations of the sarcolemma called transverse tubules, or **T-tubules**. A **triad** is a single t-tubule flanked on both sides by two terminal cisterns; this structure ensures that the muscle action potential reaches the sarcoplasmic reticulum to cause adequate calcium release for muscle contraction. There are also plentiful **mitochondria** within the sarcoplasm, as is expected with a cell that requires a lot of energy to contract.

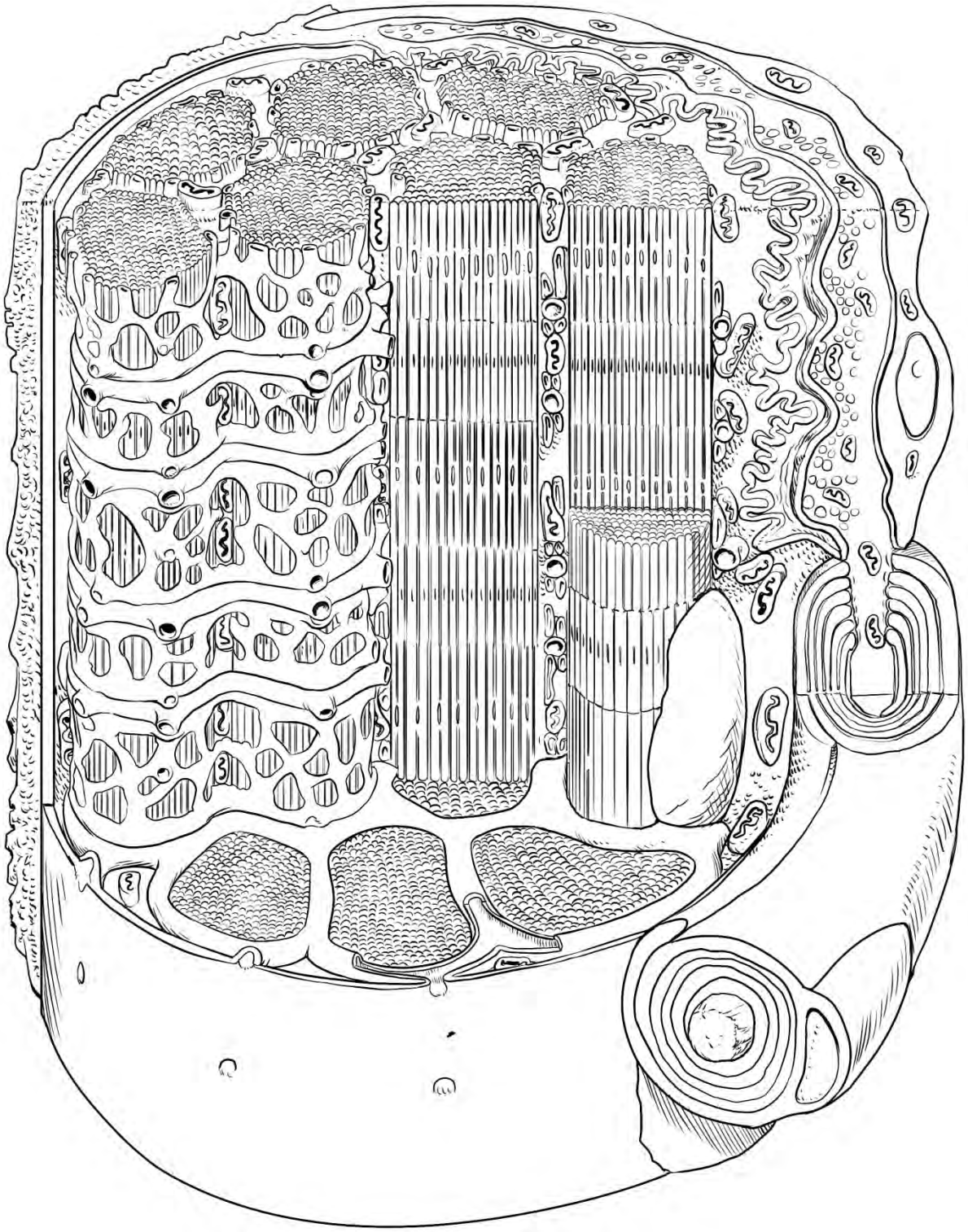
Also shown in this figure is the **neuromuscular junction**, or **motor end plate**. The **axon** of the somatic motor neuron, surrounded by a **Schwann cell**, delivers the action potential to the myofiber. The **axon terminal** of the neuron forms a synapse with the sarcolemma of the myofiber, with a thin space, called the **synaptic cleft**, separating the two cells. Within the axon terminal are many **synaptic vesicles**, which contain the neurotransmitter (acetylcholine) necessary for muscle action potential generation and contraction.

Activity:

1. Identify the following structures:

☐ Axon	☐ Sarcolemma	☐ Synaptic cleft
☐ Axon terminal	☐ Sarcoplasm	☐ Terminal cisterns
☐ Mitochondria	☐ Sarcoplasmic reticulum	☐ Triad
☐ Myofibrils	☐ Schwann cell	☐ T-tubule
☐ Nucleus of myofiber	☐ Secretory vesicles	☐ Pollex

Skeletal Muscle Tissue



Skeletal Muscle Histology

Once you are familiar with the generalized structure of the skeletal muscle tissue, you should be able to identify many of the features on prepared and stained sections of the skeletal muscle.

This slide is of myofibers and their motor neurons. Look closely to see the striations in the myofibers. You should also be able to see the motor end plates where the motor neurons innervate the myofibers.

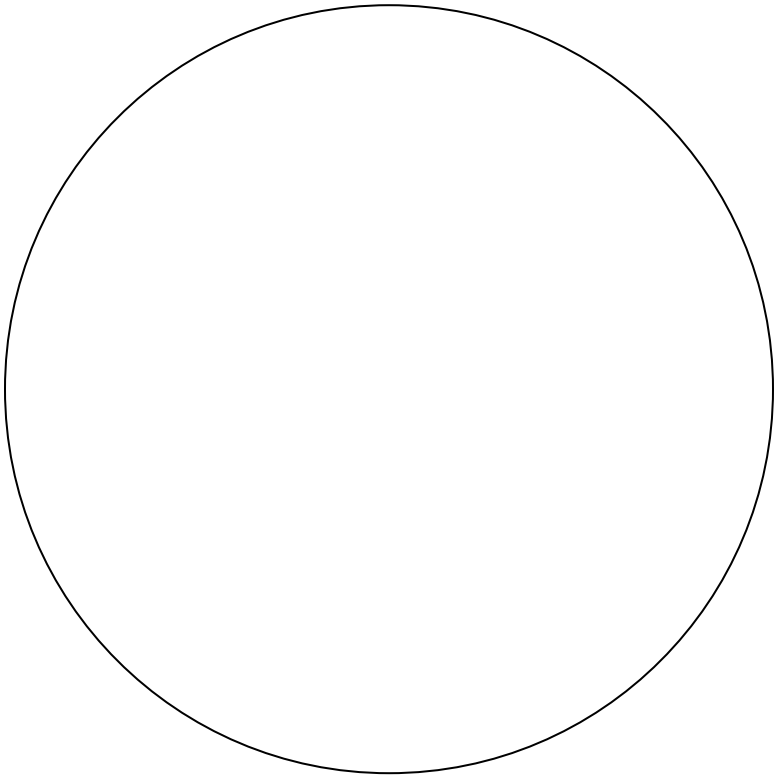
Activity:

1. Obtain slide number 40 from your slide box.
2. Using the 40X objective lens, locate the following:

    Axon
    Motor end plate (neuromuscular junction)
    Myofiber

3. Draw what you see on the following page, labelling the structures listed above.

Skeletal Muscle Histology



Facial and Neck Muscles

(Lateral view)

Facial muscles fall into one of two categories. The first set are muscles that control facial expressions. The **frontalis** muscle is responsible for drawing the scalp forward, raising the eyebrows and wrinkling the forehead. The **occipitalis** muscle, which is connected to the frontalis muscle by a large tendon, causes the scalp to move back. Most anatomists consider them to be one muscle: the occipitofrontalis muscle. The **orbicularis oculus** muscle closes the eye. The **zygomaticus major** and **zygomaticus minor** muscles are responsible for smiling. The **risorius** draws the lips laterally. The **levator labii superioris** raises the upper lip. The **orbicularis oris** closes and protrudes the lips. The **depressor labii inferioris** muscle depresses the lower lip. The **depressor anguli oris** depresses the corners of the lips. Finally, the **buccinator** flattens the cheek. The second set of muscles are involved in mastication, or chewing. The **masseter**, which originates on the zygomatic arch and maxilla and inserts on the mandible closes and retracts the jaw. The **temporalis**, which originates on the temporal bone and inserts on the mandible also closes and retracts the jaw.

There are two neck muscles that we are going to focus on in this figure. Other muscles within this region will be discussed when we cover the muscles of the posterior trunk. The **sternocleidomastoid**, which originates on the manubrium of the sternum and the clavicle, and inserts on the mastoid process of the temporal bone, is responsible for obliquely rotating the head, flexing the neck and is an accessory muscle for inhalation. The **scalenes** are a series of three muscles, which originate on the transverse processes of C2-C7, insert on ribs 1-2, and flex the neck toward the side and are also accessory muscles for inhalation.

Activity:

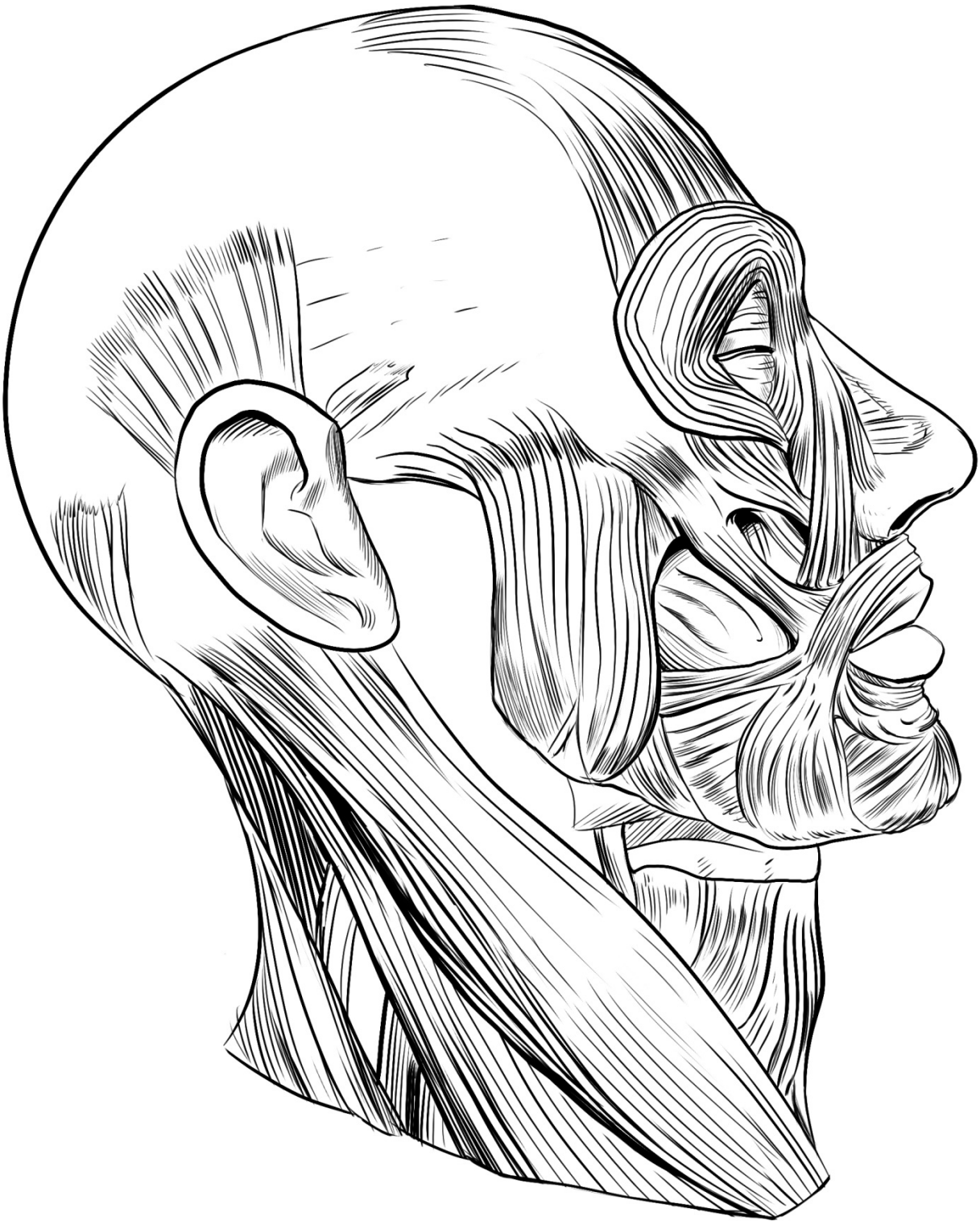
1. Identify and state the action of the following muscles:

☐ Buccinator	☐ Masseter*	☐ Scalenes*
☐ Depressor anguli oris	☐ Occipitalis	☐ Sternocleidomastoid*
☐ Depressor labii inferioris	☐ Orbicularis oculi	☐ Temporalis*
☐ Frontalis	☐ Orbicularis oris	☐ Zygomaticus major
☐ Levator labii superioris	☐ Risorius	☐ Zygomaticus minor

2. State the origin and insertion of the muscles indicated by a *.

Facial and Neck Muscles

(Lateral view)



Trunk Muscles

(Anterior view, superficial and intermediate layers)

There are four muscles in the abdomen involved in the movement of the trunk. Laterally, there are three layers of muscles. The superficial layer, the **external oblique**, has fibers that run obliquely, downward from the ribs toward the pubis. The middle layer, the **internal oblique**, has fibers that run obliquely, upward from the pelvis to the ribs. The fibers of internal oblique are perpendicular to those of the external oblique. The deepest layer, the **transversus abdominis** (which will be discussed shortly) has transversely oriented fibers. Fibers from all three muscles insert on a line down the center of the abdomen called the **linea alba**. Flanking either side of the linea alba is the **rectus abdominis**. This eight-bellied muscle extends from the pubic bone to the xyphoid process. All four muscles listed above compress the abdomen and all, except transversus abdominis, flex the vertebral column.

The thoracic muscles act on either the scapula or arm. The **pectoralis minor**, which originates on the ribs and inserts on the coracoid process, moves the scapula forward and downward. The **serratus anterior**, which originates on the ribs and inserts on the medial side of the anterior scapula, moves the scapula upward and laterally. The **pectoralis major**, which originates at the medial clavicle and sternum and inserts at the greater tubercle, flexes, adducts and medially rotates the arm.

Activity:

1. Identify and state the action of the following muscles of the superficial layer (left side):

☐ External oblique ☐ Pectoralis major* ☐ Serratus anterior*

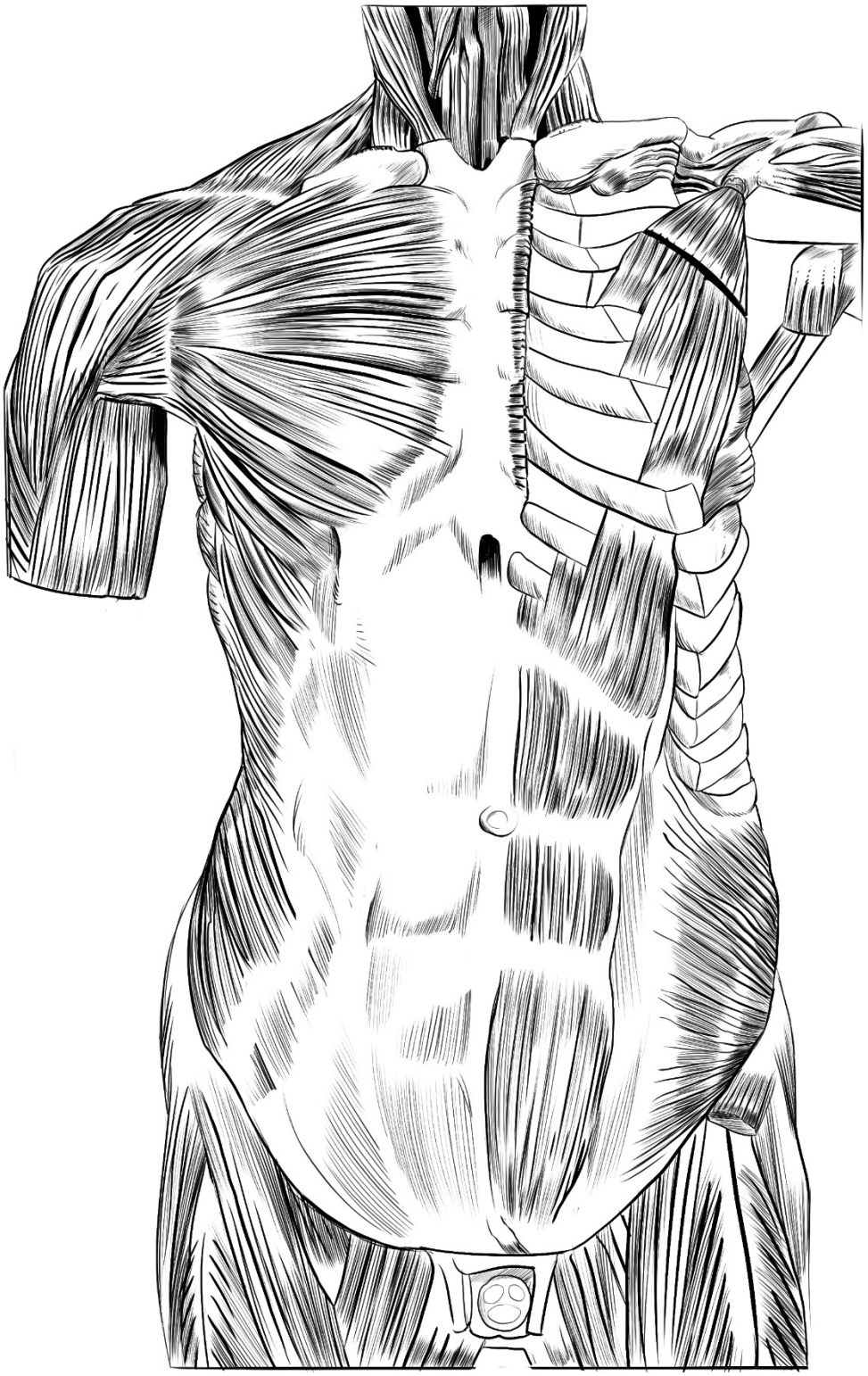
2. Identify and state the action of the following muscles of the intermediate layer (right side):

☐ Internal oblique ☐ Pectoralis minor* ☐ Rectus abdominis*

3. State the origin and insertion of the muscles with an * next to them.

Trunk Muscles

(Anterior view, superficial and intermediate layers)



Trunk Muscles
(Anterior view, deep layer)

Recall that there are three layers of muscles on the lateral sides of the abdomen. External and internal oblique form the superficial and middle layers, while **transversus abdominis** forms the deepest layer. Its transversely oriented fibers come from the lumbar region of the back, around to the midline of the abdomen to insert on the linea alba. The transversus abdominis is responsible for compression of the abdomen. But note that unlike the other abdominal muscles, it does not flex the vertebral column.

In order to view this muscle on our model, you will need view the back side of the abdominal wall.

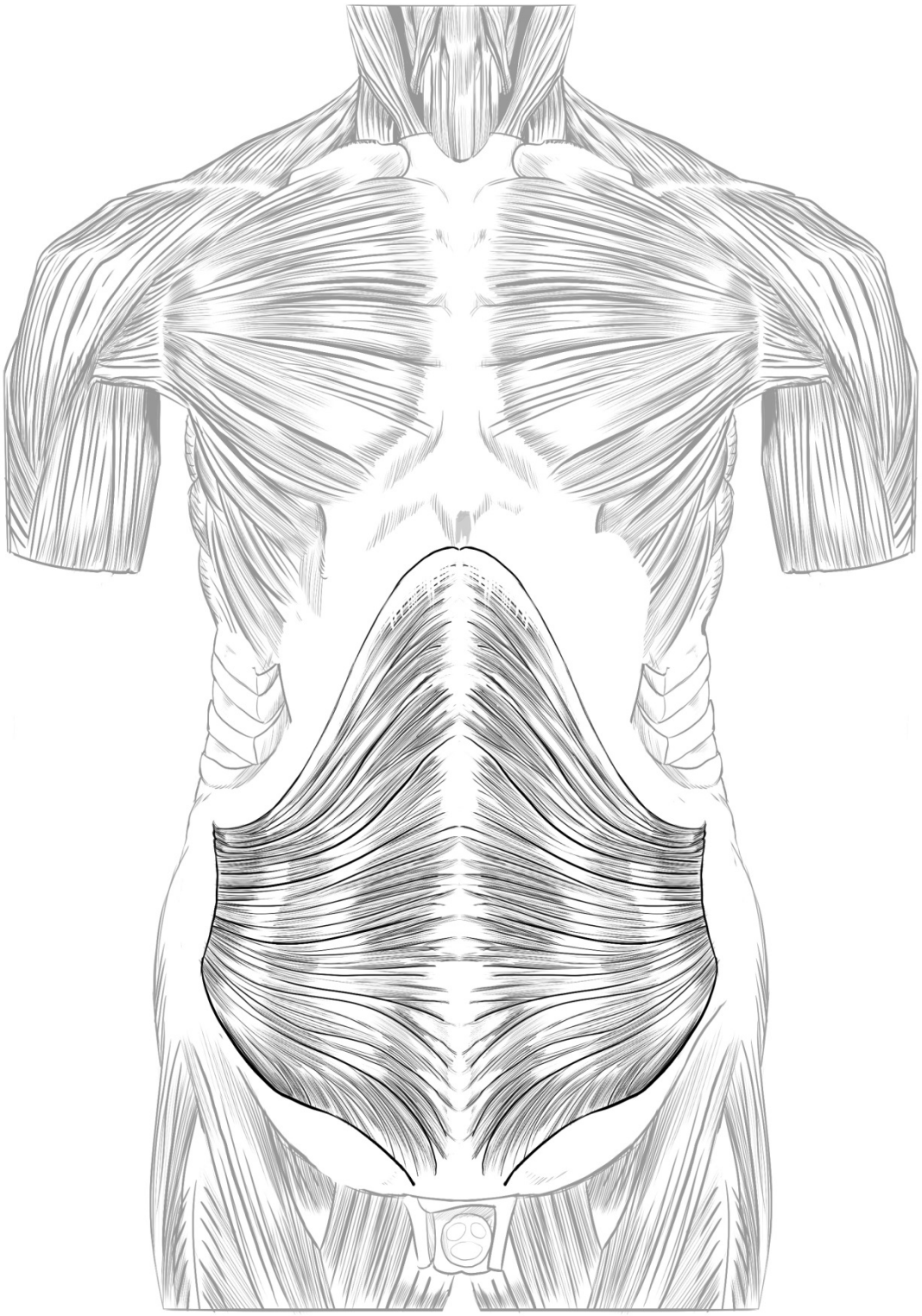
Activity:

1. Identify and state the action of the following muscle:

☐ Transversus abdominis

Trunk Muscles

(Anterior view, deep layer)



Trunk Muscles
(Posterior View)

Trapezius is the most superficial muscle on the posterior trunk. This large, diamond-shaped muscle originates from the external occipital protuberance down to T12, and inserts on the lateral clavicle, and the acromion and spine of the scapula. It is responsible for adducting, elevating and depressing the scapula. Continuing from the insertion point of the trapezius is the **deltoid**, which forms the rounded portion of the shoulder and moves the arm. This muscle originates on the lateral clavicle and the acromion and spine of the scapula, and inserts on the deltoid tuberosity. The lateral fibers cause abduction, the anterior fibers cause flexion and medial rotation, and the posterior fibers cause extension and lateral rotation. Deep muscles are shown on the left side of the figure. Beginning in the neck, **splenius**, which has two groups (capitis and cervicis) extends the head. Lateral to splenius is **levator scapulae**. This muscle originates on the transverse processes of C1-C4, inserts on the upper, medial border of the scapula, and elevates and adducts the scapula. Inferior to levator scapulae is **rhomboid minor**, which originates on the spinous processes of C7-T1, inserts on the medial border of the scapula, and adducts the scapula. Inferior to rhomboid minor is **rhomboid major**, which originates on the spinous processes of T2-T5, inserts on the medial border of the scapula, and adducts the scapula.

Latissimus dorsi is a large, superficial muscle on the lumbar region of the back. It originates from T7 down to the iliac crest, inserts on the intertubercular sulcus of the humerus, and extends, adducts and medially rotates the arm. The deep muscles of the back include **erector spinae,** which has three groups of muscles. **Spinalis** is found closest to the spine, **longissimus** is lateral to spinalis, and **iliocostalis** is the most lateral group. All three groups extend the vertebral column. Longissimus and iliocostalis also laterally flex the vertebral column.

Activity:

1. Identify and state the action of the following muscles of the superficial layer (right side):

☐ Deltoid*	☐ Latissimus dorsi*	☐ Trapezius*

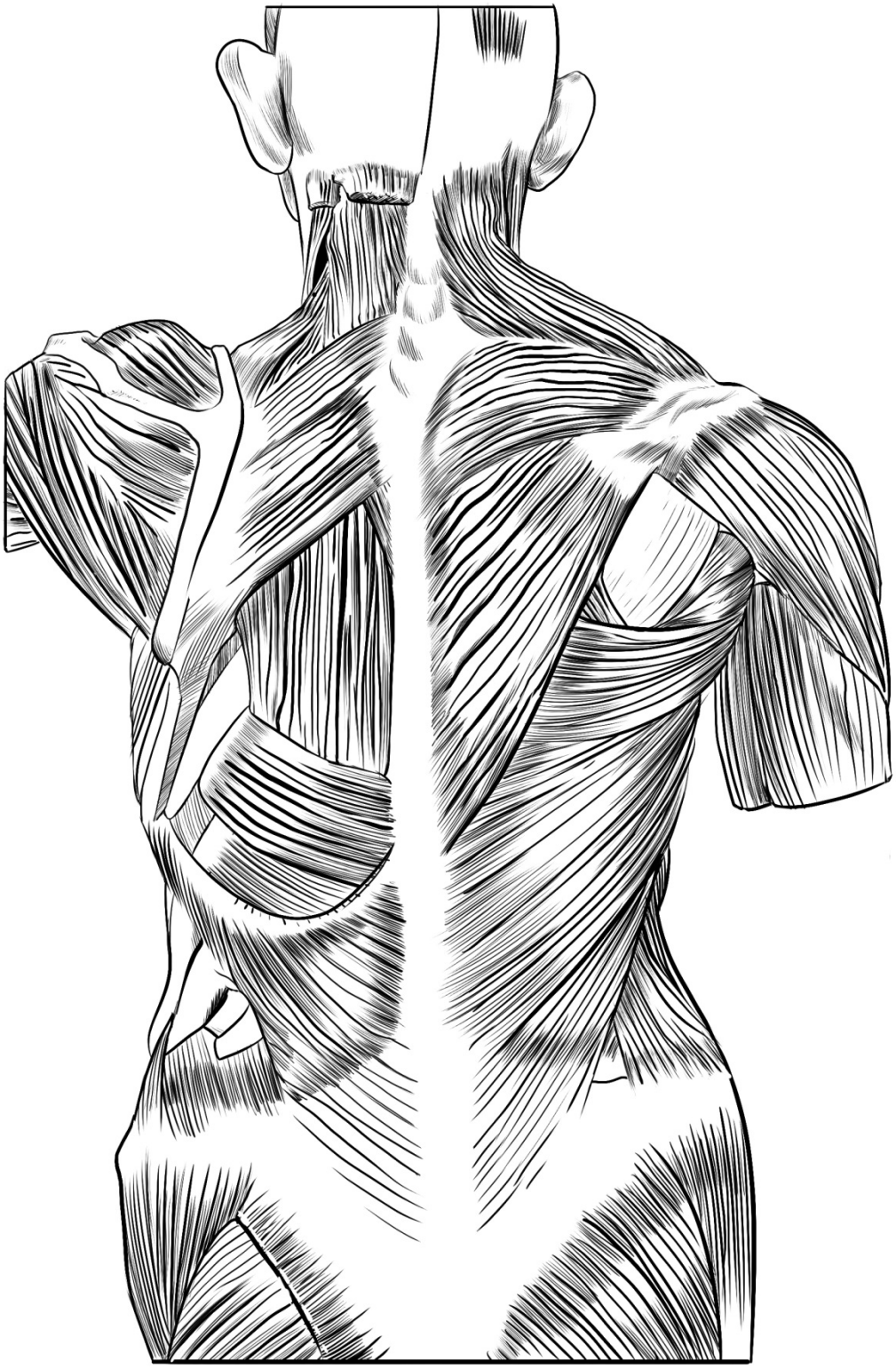
2. Identify and state the action of the following muscles of the deep layer (left side):

☐ Iliocostalis	☐ Rhomboid major*	☐ Splenius capitis
☐ Levator scapulae*	☐ Rhomboid minor*	☐ Spinalis
☐ Longissimus		

3. State the origin and insertion of the muscles with an * next to them.

Trunk Muscles

(Posterior View)



Rotator Cuff
(Posterior view)

The tendons of four scapular muscles come together to form the rotator cuff, which reinforces the shoulder joint. The muscles are collectively referred to as the SITS muscles; the letters of the acronym correspond to the first letter of the names of the muscles. The first three muscles of the rotator cuff can be seen from the posterior view: the supraspinatus, infraspinatus and teres minor. We will cover the fourth muscle – the subscapularis – shortly.

The **supraspinatus** originates on the supraspinous fossa, inserts on the greater tubercle, and abducts the arm. The **infraspinatus** originates on the infraspinous fossa, inserts on the greater tubercle, and laterally rotates the arm. The **teres minor** originates on the lateral scapula, inserts on the greater tubercle, and laterally rotates the arm.

Though not technically part of the rotator cuff, the **teres major** can also be seen from this perspective. This muscle originates on the inferior angle of the scapula, inserts on the intertubercular sulcus, and medially rotates the arm.

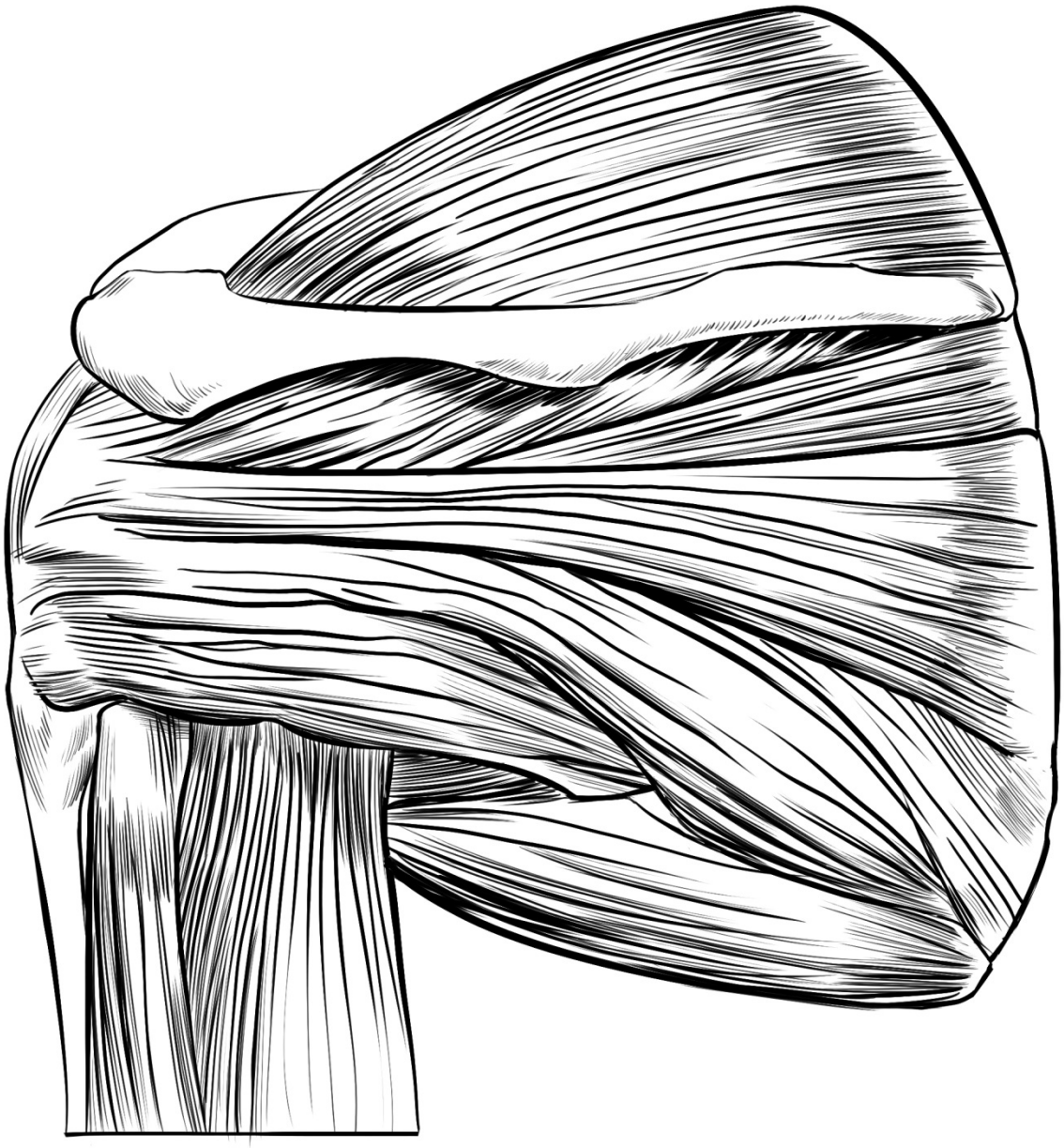
Activity:

1. Identify, and state origin, insertion and action of the following muscles:

☐	Infraspinatus	☐	Teres major
☐	Supraspinatus	☐	Teres minor

Rotator Cuff

(Posterior view)



Rotator Cuff
(Anterior View)

The remaining rotator cuff muscle, the **subscapularis**, can be seen from the anterior view. This muscle originates in the subscapular fossa and inserts on the lesser tubercle of the humerus. It medially rotates the arm.

The **teres major** can also be seen from this perspective.

Activity:

1. Identify the following muscles:

   ☐ Subscapularis ☐ Teres major

2. State the origin, insertion and action of the subscapularis.

Rotator Cuff

(Anterior View)

Arm Muscles

(Anterior View, Superficial Layer)

Muscles on the anterior arm are responsible for moving the arm and forearm. The only muscle that can be viewed in its entirety, when looking at the superficial layer, is the biceps brachii. The **biceps brachii** is a two-headed muscle that inserts via a common tendon. The **long head** originates above the glenoid cavity and the **short head** originates on the coracoid process. Both bellies of this muscle insert on the radial tuberosity. The biceps is responsible for flexing the arm, and flexing and supinating the forearm. Sitting deep to the biceps brachii are the brachialis and coracobrachialis; these muscles will be discussed shortly.

<u>Activity:</u>

1. Identify and state the origin, insertion and action of the following muscles:

☐ Biceps brachii, long head ☐ Biceps brachii, short head

Arm Muscles

(Anterior View, Superficial Layer)

Arm Muscles
(Anterior View, Deep Layer)

Once the biceps brachii is removed, the **brachialis** can be seen. This muscle originates on the shaft of the humerus and inserts on the coronoid process. As a synergist to the biceps brachii, it also flexes the forearm. The **coracobrachialis** can also be seen once the biceps has been removed. This muscle originates on the coracoid process, inserts on the medial shaft of the humerus, and flexes and adducts the arm.

Activity:

1. Identify and state the origin, insertion and action of the following muscles:

☐ Brachialis ☐ Coracobrachialis

Arm Muscles

(Anterior View, Deep Layer)

Arm Muscles
(Posterior View)

The only muscle on the posterior of the arm is the **triceps brachii**. This three-headed muscle, like the biceps, inserts via a common tendon. The **long head** originates below the glenoid fossa, the **lateral head** originates on the proximal shaft of the humerus, and the **medial head** originates on the distal shaft of the humerus. All three bellies insert on the olecranon process. The triceps is responsible for extension of the arm, and extension of the forearm.

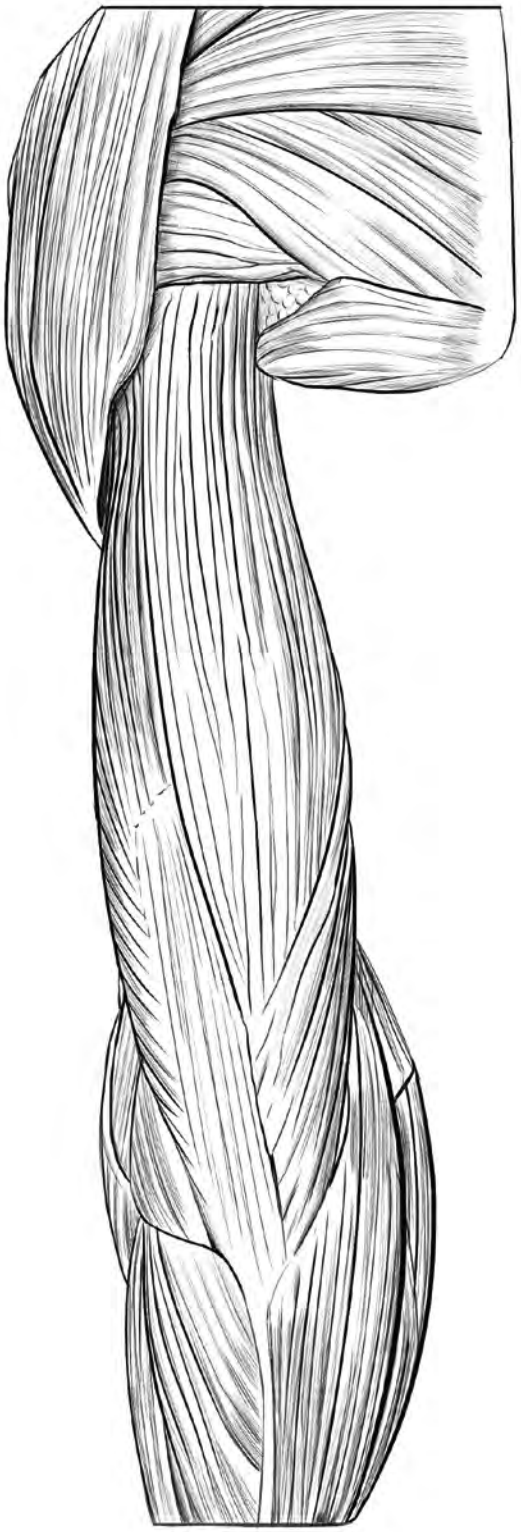
Activity:

1. Identify and state the origin, insertion and action of the following muscles:

- ☐ Triceps brachii, lateral head
- ☐ Triceps brachii, long head
- ☐ Triceps brachii, medial head

Arm Muscles

(Posterior View)



Forearm Muscles

(Anterior View, Superficial Layer)

With one exception, most of the muscles seen on the forearm are responsible for moving the wrist, hand and fingers. That one exception is **brachioradialis**, which flexes the forearm. Brachioradialis originates above the lateral epicondyle and inserts on the styloid process of the radius.

The remaining muscles of the superficial layer of the anterior forearm all originate on the medial epicondyle, but have varying insertion points and actions. The lateral most muscle is the **pronator teres**; this short muscle inserts on the lateral radius and pronates the forearm. Medial to that is the **flexor carpi radialis**, which inserts on lateral metacarpals and flexes and abducts the wrist. Next is the **palmaris longus**; this muscle inserts on the palmer aponeurosis, a layer of fascia on the palm of the hand, and flexes the wrist. Interestingly palmaris longus is missing in about 15% of the population! The most medial muscle is the **flexor carpi ulnaris**, which inserts on the medial carpals and metacarpals and flexes and adducts the wrist. Sitting just under those four muscles, but still visible from this perspective is the **flexor digitorum superficialis**. This muscle inserts on the phalanges of digits 2-5 and flexes the wrist and digits 2-5.

Activity:

1. Identify and state the origin, insertion and action of the following muscles:

- ☐ Brachioradialis
- ☐ Flexor carpi radialis
- ☐ Flexor carpi ulnaris
- ☐ Flexor digitorum superficialis
- ☐ Palmaris longus
- ☐ Pronator teres

Forearm Muscles

(Anterior View, Superficial Layer)

Forearm Muscles
(Anterior View, Deep Layer)

In this figure, flexor digitorum superficialis, pronator teres and flexor carpi radialis have been removed so you can identify the deep muscles of the anterior forearm. From this perspective you can see two superficial muscles: **brachioradialis** and **flexor carpi ulnaris**.

Flexor digitorum profundus sits just deep to flexor digitorum superficialis. This muscle originates on the proximal ulna, inserts onto the distal phalanges of digits 2-5, and flexes the fingers. **Pronator quadratus** is the deepest of all the muscles on the anterior forearm, and sits just proximal to the wrist. It originates on the distal ulna, inserts on the distal radius, and as its name implies, it pronates the forearm.

Activity:

1. Identify and state the origin, insertion and action of the following muscles:

☐ Brachioradialis	☐ Flexor digitorum profundus
☐ Flexor carpi ulnaris	☐ Pronator quadratus

Forearm Muscles

(Anterior View, Deep Layer)

Forearm Muscles

(Posterior View, Superficial Layer)

Similar to the anterior forearm, the posterior forearm muscles have a common point of origin. In this case, the origin is the lateral epicondyle. There is one exception, which is **extensor carpi radialis longus**. This lateral muscle originates just above the lateral epicondyle, inserts on the lateral metacarpals, and extends and abducts the wrist. Next to that muscle is the **extensor carpi radialis brevis**, which inserts on the lateral metacarpals and extends and abducts the wrist. Next is the **extensor digitorum**, which inserts on the phalanges of digits 2-5 and extends the wrist and digits 2-5. Next is a small muscle called **extensor digiti minimi**, which inserts on the phalanges of digit #5 and extends digit #5. Finally, there is the **extensor carpi ulnaris**, which inserts on the medial metacarpals and flexes and adducts the wrist.

<u>Activity:</u>

1. Identify and state the origin, insertion and action of the following muscles:

- ☐ Extensor carpi radialis brevis
- ☐ Extensor carpi radialis longus
- ☐ Extensor carpi ulnaris
- ☐ Extensor digiti minimi
- ☐ Extensor digitorum

Forearm Muscles

(Posterior View, Superficial Layer)

Thigh Muscles
(Anterior View, Superficial Layer)

Muscles of the anterior thigh are all responsible for moving the thigh and leg. The most superficial muscle is **sartorius**, which originates at the anterior superior iliac spine, then runs obliquely across the thigh to insert on the medial side of the proximal tibia. This muscle is responsible for flexing, abducting and laterally rotating the thigh, and flexing the leg.

The majority of the anterior thigh is formed by the **quadriceps femoris** muscle, a four headed muscle with a common insertion point: the patella and tibial tuberosity. The quadriceps femoris is responsible for extending the leg. Three of the four heads can be seen on the superficial layer. The longest head is the **rectus femoris**, which originates on the anterior inferior iliac spine. In addition to extending the leg, this head also flexes the thigh. Lateral to rectus femoris is **vastus lateralis**, which originates on the greater trochanter and linea aspera. Medial to rectus femoris is **vastus medialis**, which originates on the linea aspera. The fourth head will be discussed shortly.

There are several adductor muscles of the thigh, one of which can be seen here. **Adductor longus** originates on the pubis, inserts on the linea aspera and is responsible for adducting, flexing and medially rotating the thigh.

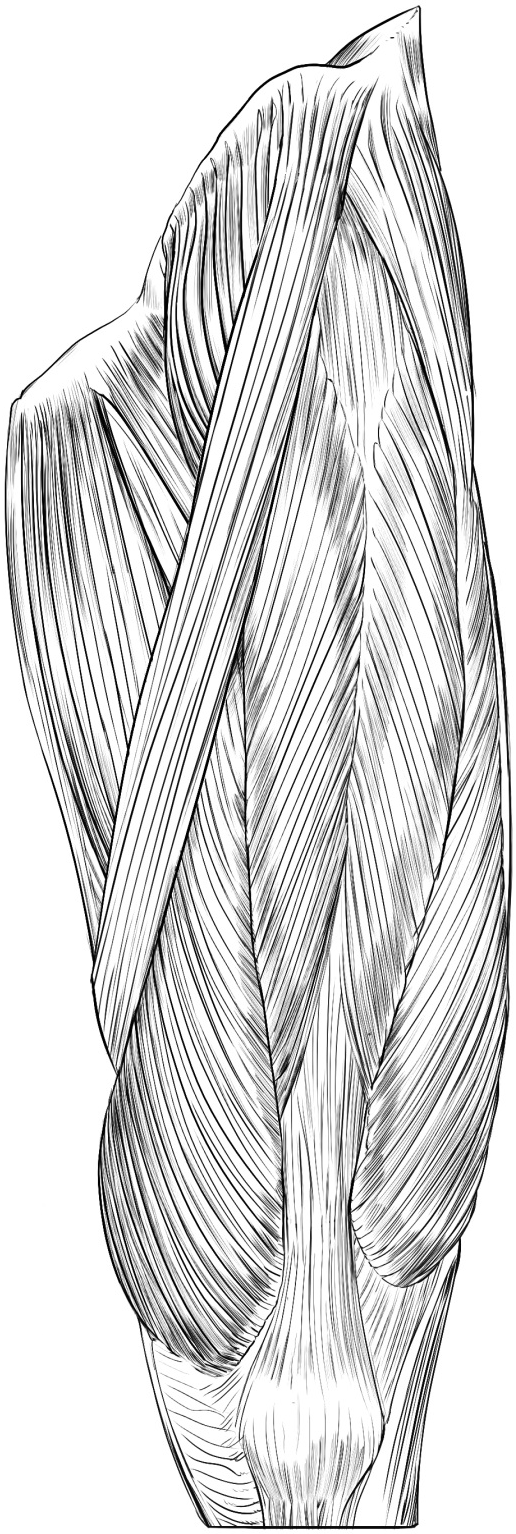
Activity:

1. Identify and state the origin, insertion and action of the following muscles:

- ☐ Adductor longus
- ☐ Rectus femoris
- ☐ Sartorius
- ☐ Vastus lateralis
- ☐ Vastus medialis

Thigh Muscles

(Anterior View, Superficial Layer)



Thigh Muscles
(Anterior View, Deep Layer)

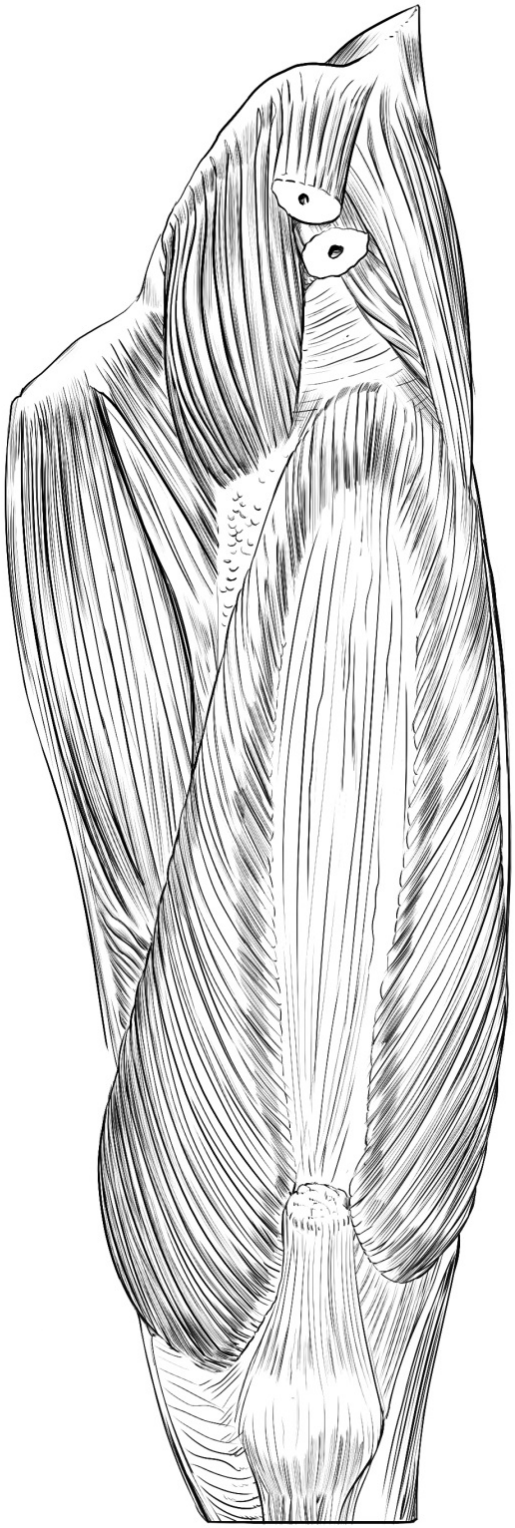
In this figure, sartorius and rectus femoris have been removed so you can see the deep muscles of the anterior thigh. The fourth head of quadriceps can be seen. **Vastus intermedius** lies in between vastus lateralis and vastus medialis. It originates on the anterior and lateral surfaces of the proximal femur, inserts on the patella and tibial tuberosity, and extends the leg. Superior to vastus intermedius is **iliopsoas**. This muscle is actually composed of two muscles with a common insertion point. Iliacus originates on the ilium just under the iliac crest and psoas originates on the lumbar spine. Both insert on the lesser trochanter and flex the thigh.

Activity:

1. Identify and state the origin, insertion and action of the following muscles:

- ☐ Adductor longus
- ☐ Iliopsoas
- ☐ Vastus intermedius
- ☐ Vastus lateralis
- ☐ Vastus medialis

Thigh Muscles
(Anterior View, Deep Layer)



Thigh Muscles
(Posterior View, Superficial Layer)

Much like the anterior thigh, muscles of the posterior thigh are all responsible for moving the thigh and leg. There are three gluteus muscles, one of which can be seen from the superficial perspective. **Gluteus maximus**, the largest of the three, originates on the ilium, sacrum and coccyx, inserts on gluteal tuberosity, and is responsible for extending, abducting and laterally rotating the thigh.

There are three muscles that run down the length of the posterior thigh, which are collectively referred to as the **hamstrings**. These muscles all extend the thigh and flex the knee. The **biceps femoris** forms that lateral portion of the hamstrings. This muscle has two heads with a common insertion point on the lateral condyle of the tibia. The **long head** originates on the ischial tuberosity, while the **short head** originates on the linea aspera. The remaining two muscles form the medial portion of the hamstrings. **Semiteninosus** is the more superficial of the two; it originates on the ischial tuberosity and inserts on the medial shaft of the proximal tibia. The deeper muscle, **semimembranosus**, originates on the ischial tuberosity as well, but inserts on the medial condyle of the tibia.

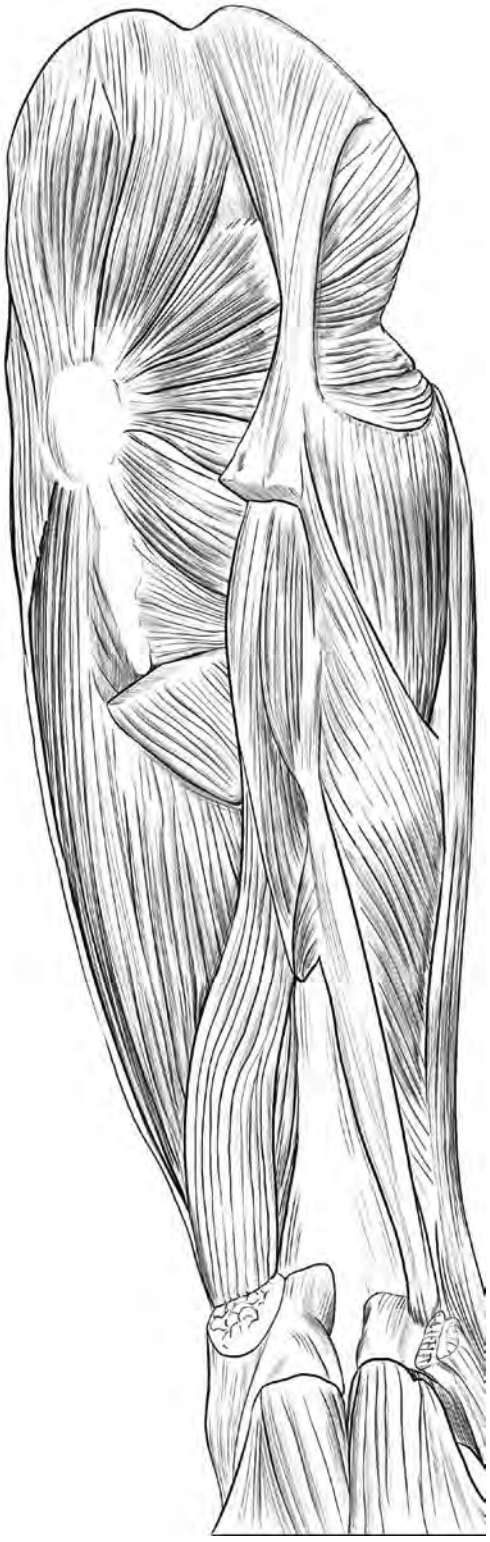
Activity:

1. Identify and state the origin, insertion and action of the following muscles:

- ☐ Biceps femoris, long head
- ☐ Biceps femoris, short head
- ☐ Gluteus maximus
- ☐ Semimembranosus
- ☐ Semitendinosus

Thigh Muscles

(Posterior View, Superficial Layer)



Thigh Muscles
(Posterior View, Deep Layer)

In this view, gluteus maximum, biceps femoris long head, as well as semiteniosus and semimembranosus have been removed so you can identify the deep muscles of the posterior thigh. The **biceps femoris, short head** can be seen, as well as **vastus lateralis**.

A second gluteus muscle, **gluteus medius**, can be seen. Gluteus medius is deeper and smaller than gluteus maximus. This muscle originates on the ilium, inserts on the greater trochanter, and abducts and medially rotates the thigh.

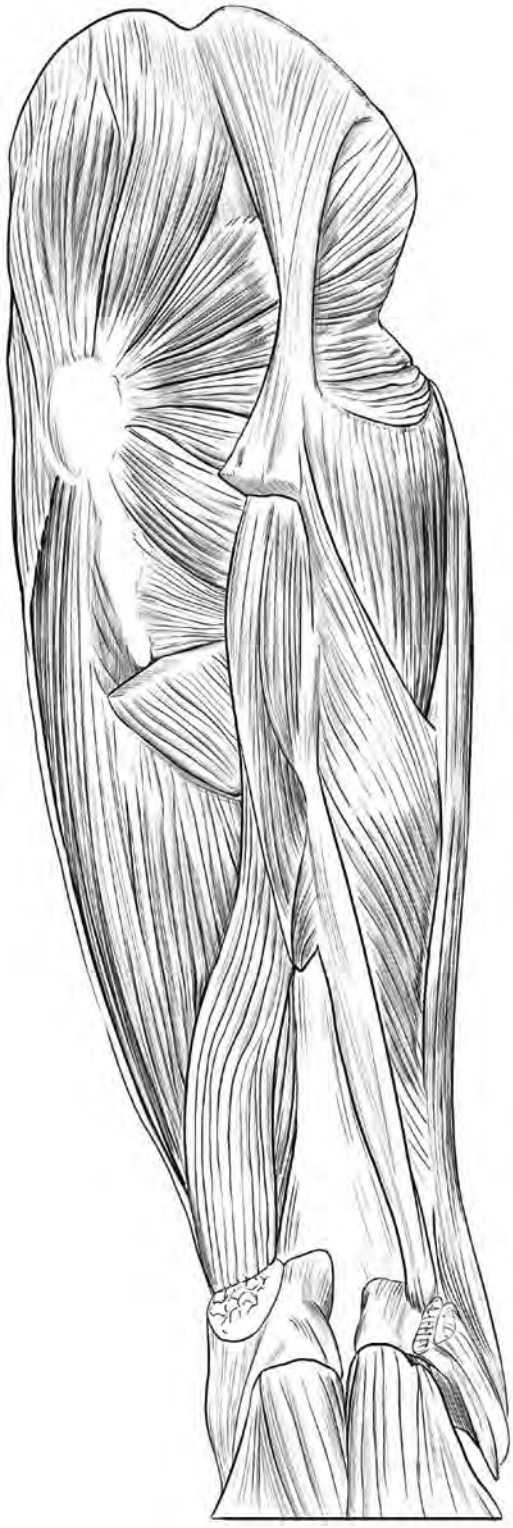
Two other pelvic muscles can be identified. **Piriformis** is found just distal to gluteus medius. This muscle originates on the sacrum, inserts on the greater trochanter, and laterally rotates the thigh. **Quadratus femoris** is distal to piriformis. It originates on the ischial tuberosity, inserts on the intertrochanteric crest and laterally rotates the thigh.

Activity:

1. Identify and state the origin, insertion and action of the following muscles:

- ☐ Biceps femoris, short head
- ☐ Gluteus medius
- ☐ Piriformis
- ☐ Quadratus femoris
- ☐ Vastus lateralis

Thigh Muscles
(Posterior View, Deep Layer)



Thigh Muscles
(Lateral View)

From the lateral perspective, you can see several of the muscles that we covered on the anterior view, including **rectus femoris** and **vastus lateralis**. Several posterior muscles can also be seen, including **gluteus maximus** and **biceps femoris**.

The most lateral muscle of the thigh is **tensor fasciae latae**. This muscle is unusual because it has a very small belly and a very long tendon, called the **iliotibial tract**. Tensor fasciae latae originates on iliac crest and anterior superior iliac spine and inserts on the lateral condyle of the tibia via the iliotibial tract. It is responsible for flexing, abducting, and medially rotating the thigh.

Activity:

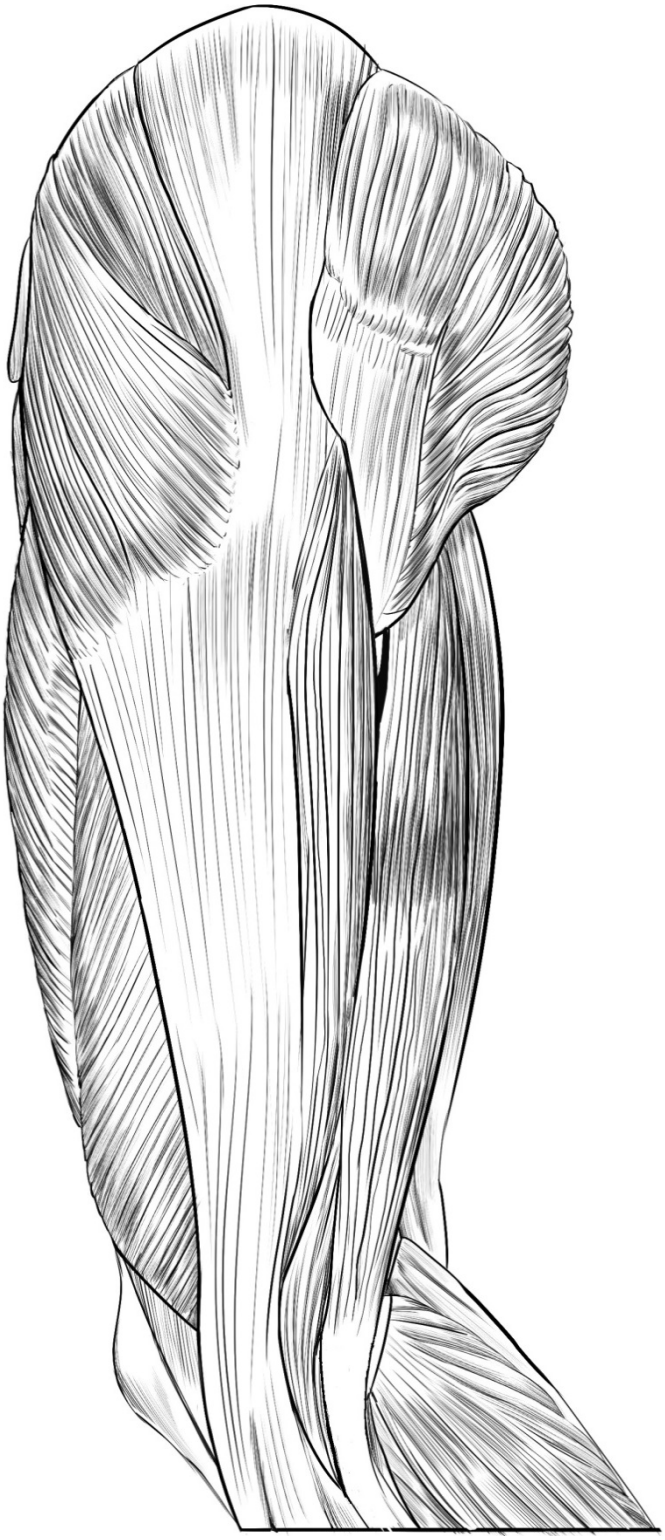
1. Identify and state the origin, insertion and action of the following muscles:

☐ Biceps femoris	☐ Tensor fasciae latae
☐ Gluteus maximus	☐ Vastus lateralis
☐ Rectus femoris	

2. Identify the following structure:

☐ Iliotibilal tract

Thigh Muscles
(Lateral View)



Thigh Muscles
(Medial View)

From the medial perspective, you can see several of the muscles that we covered on the anterior view, including **sartorius**, **vastus medialis** and **adductor longus**. Several posterior muscles, including **gluteus maximus**, **semitendiosus** and **semimembranosus**, can also be seen.

The most medial muscle of the thigh is **gracilis**. This relatively flat muscle originates on the pubis, inserts on the medial tibia, and adducts and medially rotates the thigh and flexes the leg.

A second adductor muscle can also be seen. The majority of **adductor magnus** is found posterior to gracilis, with a remaining small portion visible anterior to gracilis and distal to adductor longus. This muscle originates on the ischial tuberosity and the pubis and inserts on the line linea aspera. The anterior portion of the muscle adducts, flexes and medially rotates the thigh, like the adductor longus. The posterior portion extends the thigh.

Activity:

1. Identify and state the origin, insertion and action of the following muscles:

☐	Adductor longus	☐	Sartorius
☐	Adductor magnus	☐	Semimembranosus
☐	Gluteus maximus	☐	Semitendinosus
☐	Gracilis	☐	Vastus medialis

Thigh Muscles
(Medial View)

Leg Muscles
(Anterior View)

The three muscles of the anterior compartment of the leg act on the ankle and toes. **Tibialis anterior** sits just lateral to the shaft of the tibia. It originates on the lateral condyle of the tibia, inserts on the medial cuneiform and first metatarsal, and dorsiflexes and inverts the foot. **Extensor digitorum longus** sits lateral to tibialis anterior. It originates on the lateral condyle of the tibia, inserts on the middle and distal phalanges of digits 2-5, and dorsiflexes the foot and extends digits 2-5. **Extensor hallucis longus** is deep to both extensor digitorum longus and tibialis anterior. It originates on the fibula, inserts on the distal phalanx of digit 1, and dorsiflexes the foot and extends digit 1 (the hallux).

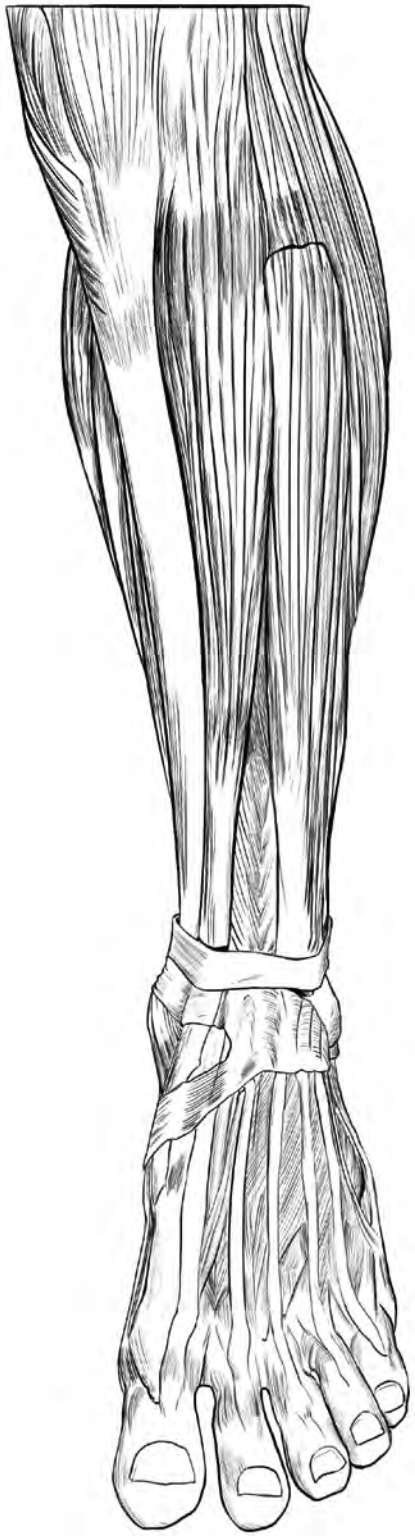
Activity:

1. Identify and state the origin, insertion and action of the following muscles:

☐ Extensor digitorum longus ☐ Tibialis anterior

☐ Extensor hallucis longus

Leg Muscles
(Anterior View)



Leg Muscles

(Posterior View, Superficial and Intermediate Layers)

The muscles of the posterior leg all work together to plantar flex the foot. A pair of muscles, collectively referred to as the **triceps surae**, with a common insertion point on the calcaneus, can be seen on the superficial and intermediate layers. **Gastrocnemius**, the more superficial of the two, originates on the lateral and medial condyles of the femur. **Soleus**, the deeper muscle, originates on the proximal tibia and fibula.

This image shows both the gastrocnemius and the soleus. The medial belly of the gastrocnemius has been removed so you can see the medial portion of the soleus underneath.

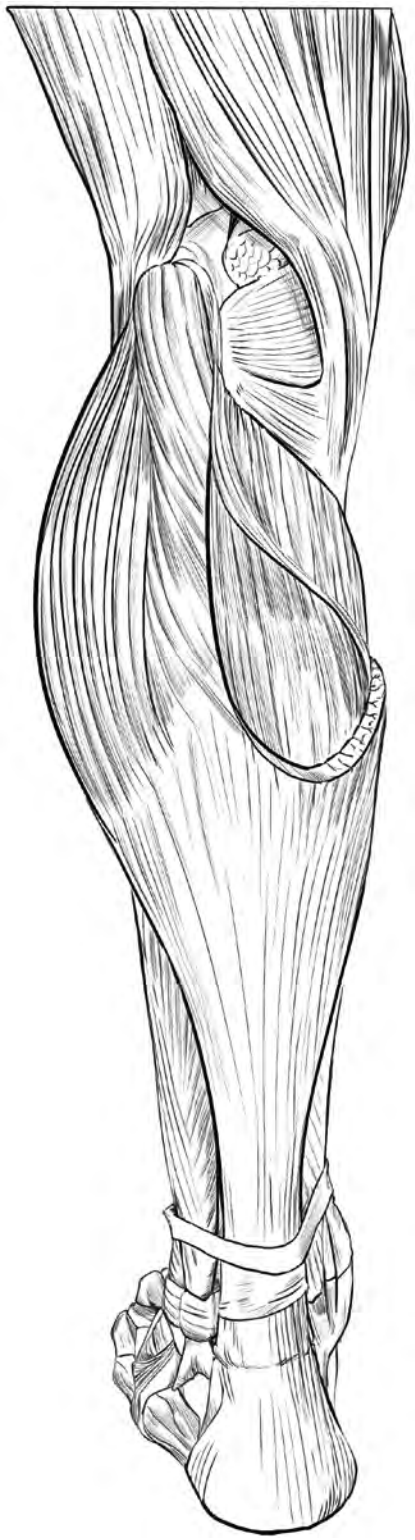
Activity:

1. Identify and state the origin, insertion and action of the following muscle:

☐ Gastrocnemius ☐ Soleus

Leg Muscles

(Posterior View, Superficial and Intermediate Layers)



Leg Muscles
(Posterior View, Deep Layer)

In this image, gastrocnemius and soleus have been removed so you can identify the deep muscles of the posterior leg. The most proximal of the four muscles in the deep layer is **popliteus**. This muscle originates on the lateral condyle of the femur, inserts on the proximal tibia and flexes and medially rotates the leg. Below popliteus are three muscles that act on the ankle joint to move the foot. **Flexor digitorum longus** originates on the posterior tibia, inserts on the distal phalanges of toes 2-5, and plantar flexes and inverts the foot, and flexes toes 2-5. **Flexor hallucis longus** originates on the shaft of the fibula, inserts on the distal phalanx of the great toe, and plantar flexes and inverts the foot, and flexes the great toe. **Tibialis posterior** originates on the proximal tibia and fibula, inserts on the navicular and medial cuneiform tarsals, and inverts and plantar flexes the foot.

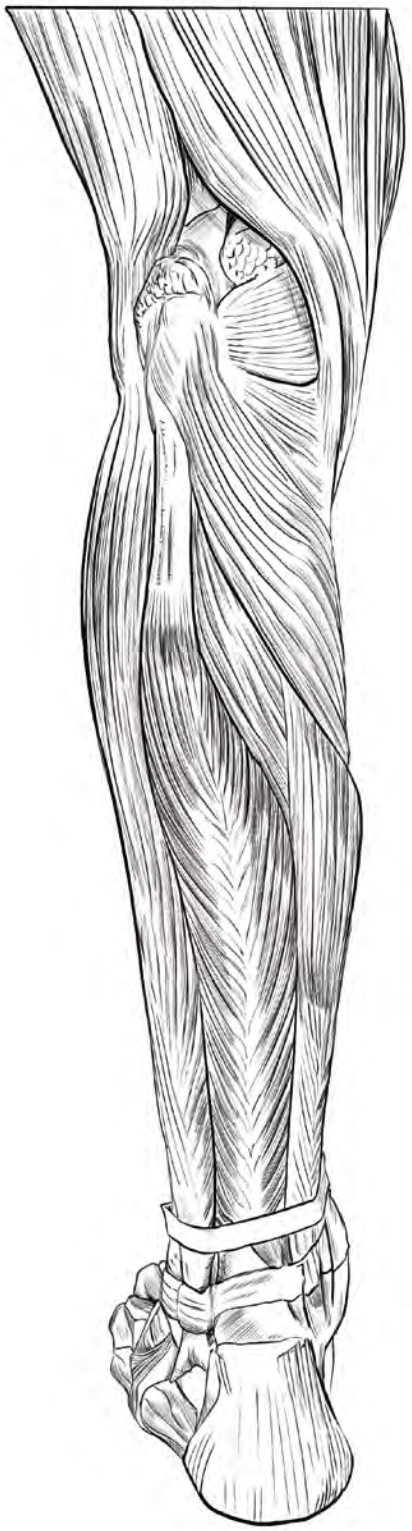
Note that **fibularis brevis and longus** can also be seen on this figure.

Activity:

1. Identify and state the origin, insertion and action of the following muscle:

☐	Fibularis brevis	☐	Flexor hallucis longus
☐	Fibularis longus	☐	Popliteus
☐	Flexor digitorum longus	☐	Tibialis posterior

Leg Muscles
(Posterior View, Deep Layer)



Leg Muscles
(Lateral View)

The lateral compartment of the leg act includes two fibularis muscles, one long and one short, both of which are responsible for plantar flexion and eversion of the foot. **Fibularis longus** originates on the head of the fibula and inserts on the first metatarsal and medial cuneiform. **Fibularis brevis** originates on the distal fibula and inserts on the fifth metatarsal.

Note that from this perspective you can also see several muscles from the anterior compartment (**tibialis anterior**, **extensor digitorum longus** and **extensor hallucis longus**), and several from the posterior compartment (**gastrocnemius** and **soleus**).

Activity:

1. Identify and state the origin, insertion and action of the following muscles:

- ☐ Extensor digitorum longus
- ☐ Extensor hallucis longus
- ☐ Fibularis brevis
- ☐ Fibularis longus
- ☐ Gastrocnemius
- ☐ Soleus
- ☐ Tibialis anterior

Leg Muscles
(Lateral View)