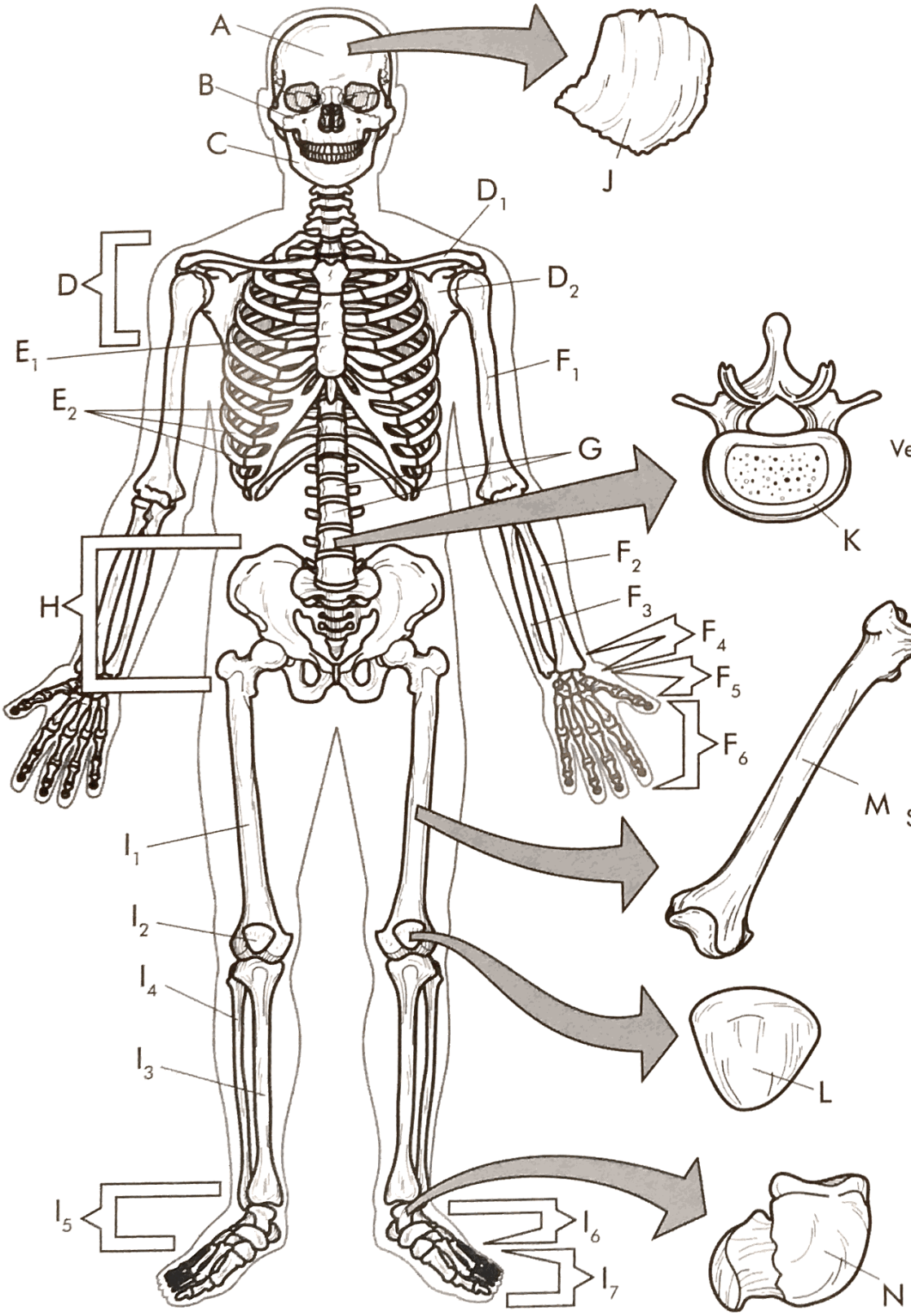


Cranium	A	○
Face	B	○
Mandible	C	○
Pectoral girdle	D	○
Clavicle	D_1	○
Scapula	D_2	○
Sternum	E_1	○
Ribs	E_2	○
Humerus	F_1	○
Radius	F_2	○
Ulna	F_3	○
Carpals	F_4	○
Metacarpals	F_5	○
Phalanges	F_6	○
Vertebral column	G	○
Pelvic girdle	H	○
Femur	I_1	○
Patella	I_2	○
Tibia	I_3	○
Fibula	I_4	○
Tarsals	I_5	○
Metatarsals	I_6	○
Phalanges	I_7	○
Flat bone	J	○
Irregular bone	K	○
Sesamoid bone	L	○
Long bone	M	○
Short bone	N	○

the SKELETON

The human skeleton consists of 206 bones differing in size, shape, weight, and in some cases, composition. This diversity is related to the structural and mechanical functions of the skeleton, which include supporting the body, protecting the body cavities, acting as levers for muscle activity, and providing a site for blood cell development.

The skeleton is divided into two major parts: The axial skeleton is composed of the skull, vertebral column, sternum, and ribs; and the appendicular skeleton is composed of the upper and lower extremities and the supporting girdles. This plate will discuss the skeleton with the bones in place as a preview of the following plates, which feature the bones in detail. We also note the five different types of bones found in the skeleton.

Looking over the plate, you will note that it contains a view of the skeleton in the anatomical position with the palms facing outward. An anterior view is presented. We also call out several of the bones to indicate the various types that are present. As you read about the skeleton, color the appropriate titles and the bones in the plate. There may be some overlapping, and pale colors are suggested for these areas. Begin by coloring the main title The Skeleton.

The first structure of the axial skeleton is the skull. This structure houses the brain and is the location of many sensory organs. The two main features of the skull are the **cranium (A)** and the **face (B)**. The skull contains 22 bones, many of which are paired; the face contains 14 bones, which are discussed in a future plate. The only bone not attached directly to the other bones of the skull is the lower jaw bone, the **mandible (C)**.

The skull and upper torso of the body are supported by another portion of the axial skeleton, the **vertebral column (G)**. There are 31 bones in this column, which extends along the dorsal aspect of the body and connects to the thoracic cage. At its ventral aspect, the thoracic cage has a three-part bone called the **sternum (E_1)** and a set of 12 **ribs (E_2)** connecting the sternum to the vertebral column.

Having examined the axial skeleton, we now move to the appendicular skeleton and preview some of its essential bones. As you encounter the bones in the reading, locate their titles in the titles list and color the titles and bones in the plate. Two brackets demarcate the main sections.

At the upper portion of the body, the upper extremity is composed of the pectoral girdle and arm bones. The **pectoral girdle (D)** is outlined by the bracket, which should be colored. It contains two bones: The collar bone or **clavicle (D_1)** at the anterior aspect, and a flat, triangular bone called the **scapula (D_2)** at the posterior portion of the body.

Articulating with the pectoral girdle is the upper arm bone called the **humerus (F_1)**. The two lower arm bones articulating with the humerus are the **radius (F_2)** and the **ulna (F_3)**. The wrist bones are the **carpals (F_4)**, while the hand bones are **metacarpals (F_5)** and the finger bones are **phalanges (F_6)**.

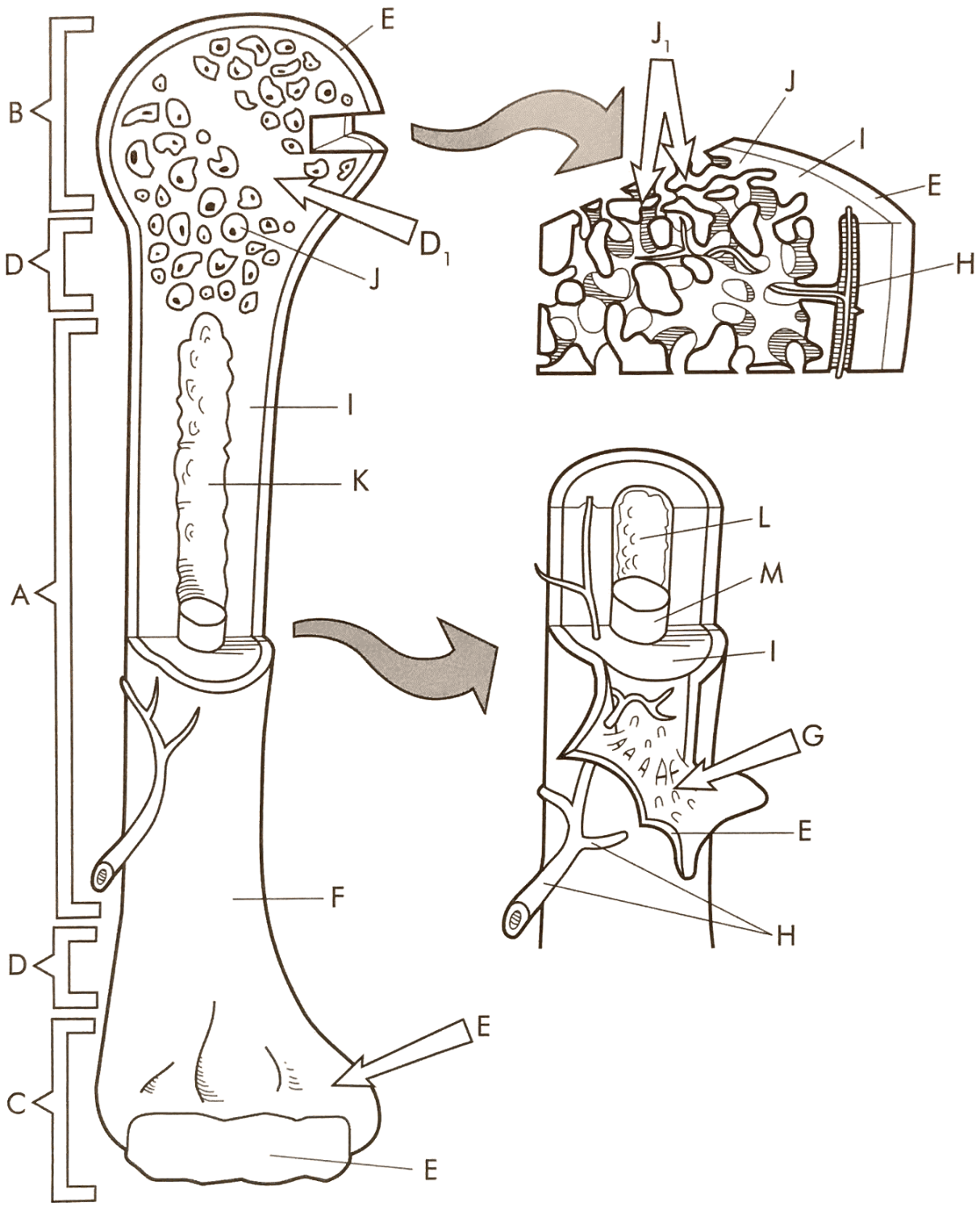
At the lower portion of the body is the **pelvic girdle (H)**, indicated by the bracket. This bone appears single, but it is composed of three fused bones called the ilium, ischium, and pubis. Articulating with the pelvic girdle is the lower extremity. It consists of the thigh bone, the **femur (I_1)**, the knee cap called the **patella (I_2)**, and two lower leg bones, the **tibia (I_3)** and the **fibula (I_4)**. The ankle contains the **tarsals (I_5)**, and the foot bones are **metatarsals (I_6)**. The toes contain **phalanges (I_7)**. This completes the appendicular skeleton.

The plate concludes with a discussion of the five different types of bones making up the skeleton. Here you are referred to the detailed views off to the side, and bold colors may be used for these bones.

Bones are classified according to their function in the body such as support, protection, or movement. They are also classified by their shape, which gives an indication of the mechanical function of the bone. An example of a **flat bone (J)** is a bone of the skull. These bones are thin and are used as protective devices. The scapula and ribs are other flat bones. An **irregular bone (K)** is typified by the vertebra. Many extensions to which muscles often attach are found on these bones. The vertebra shown is part of the vertebral column.

A **sesamoid bone (L)** is illustrated by the patella. These small bones are usually embedded in tendons and are used to protect the integrity of the tendon. A **long bone (M)** is used for movement. In the leg, for example, the femur acts as an attachment point for the muscles, and as they contract, they cause the bone to move.

The last bone we consider is the **short bone (N)**. These bones have similar dimensions but an irregular shape. They are found in the wrists and ankles as carpals and tarsals, respectively. Short bones unite with numerous other bones in their area and provide a variety of movements at that body part.



Diaphysis	A	○	Articular cartilage	E	○	Spongy bone	J	○
Proximal epiphysis	B	○	Periosteum	F	○	Trabeculae	J_1	○
Distal epiphysis	C	○	Sharpey's fibers	G	○	Medullary cavity	K	○
Metaphysis	D	○	Nutrient arteries	H	○	Endosteum	L	○
Epiphyseal plate	D_1	○	Compact bone	I	○	Marrow	M	○

ANATOMY of a LONG BONE

Bones come in many sizes and shapes. Certain bones, such as those in the joints of the skull, are extremely small and varied in shape. By contrast, the femur (the thigh bone) is almost two feet in length in some people.

The shape of a bone is consistent with its functions. The femur, for instance, withstands great weight and pressure as it provides support for the body and attachment points for many skeletal muscles. Moreover, the hollow cylindrical design of the femur provides maximum strength with minimum weight.

The long bones of the body are considerably longer than they are wide. All bones of the limbs, with the exception of the patella and wrist and ankle bones, are considered long bones. A long bone has a shaft and two structurally complex ends. Most long bones contain compact bone, but there is also a considerable amount of spongy bone in the interior. In this plate, we shall examine the anatomy of the long bone and point out some of the physiological processes related to the bone's structure.

Begin the plate by coloring the main title Anatomy of a Long Bone. Then look over the plate, and as you read below, color the titles and brackets pointing out areas of the long bone. Dark colors may be used for these brackets.

The diaphysis (A) is the shaft or long, main portion of the bone. It consists of a thick cylinder of compact bone enclosing a large, central cavity called the medullary or marrow cavity. The expanded ends of the bone are called epiphyses (singular, epiphysis). The **proximal epiphysis (B)** is the end of the bone close to the central axis of the body. The **distal epiphysis (C)** is the end of the bone farthest from the body's central axis. The epiphyses articulate with other bones to form joints. The **metaphysis (D)** is the region where the diaphysis joins the epiphysis and is the site of the **epiphyseal plate (D_1)**, which is pointed out by an arrow on the plate. The epiphyseal plate is a layer of hyaline cartilage where the diaphysis lengthens during the development of the long bone. An epiphysis and metaphysis exist at both ends of the bone.

Continue the plate by studying the parts and structures of the long bone. As you come upon the structures in the reading, color their titles and the structures in all views of the long bone. Use lighter colors for the structures and darker colors for arrows pointing to processes and areas. This will allow you to see the structures where they join and the important areas of the bone.

Where the epiphysis forms a joint with another bone, the epiphysis is covered with a thin layer of hyaline cartilage called the **articular cartilage (E)**. The articular cartilage absorbs shocks at the joint and reduces the friction where bones come together to form a joint. The **periosteum (F)** surrounds the diaphysis only. It is a membrane composed of an outer fibrous area and inner fibrous layer. The outer fibrous layer contains dense connective tissue with blood vessels, nerves, and lymph vessels. Its inner layer, the osteogenic layer, contains blood vessels and bone cells. The periosteum is the main center for the growth and development of bone. Its vessels supply nutrition to the bone. It is also a point where ligaments and tendons attach. The periosteum is bound to the bone by a set of connective tissue fibers called **Sharpey's fibers (G)**. **Nutrient arteries (H)** enter the periosteum bringing proteins, minerals, carbohydrates, and other essential materials for bone growth.

Now color the titles for the compact bone and spongy bone, then locate the areas of compact bone and spongy bone in the plate. As your read about these two types of bone below, color in the appropriate areas in three places on the plate. Light colors such as pale tans and grays should be used so you can see the textures of the bone.

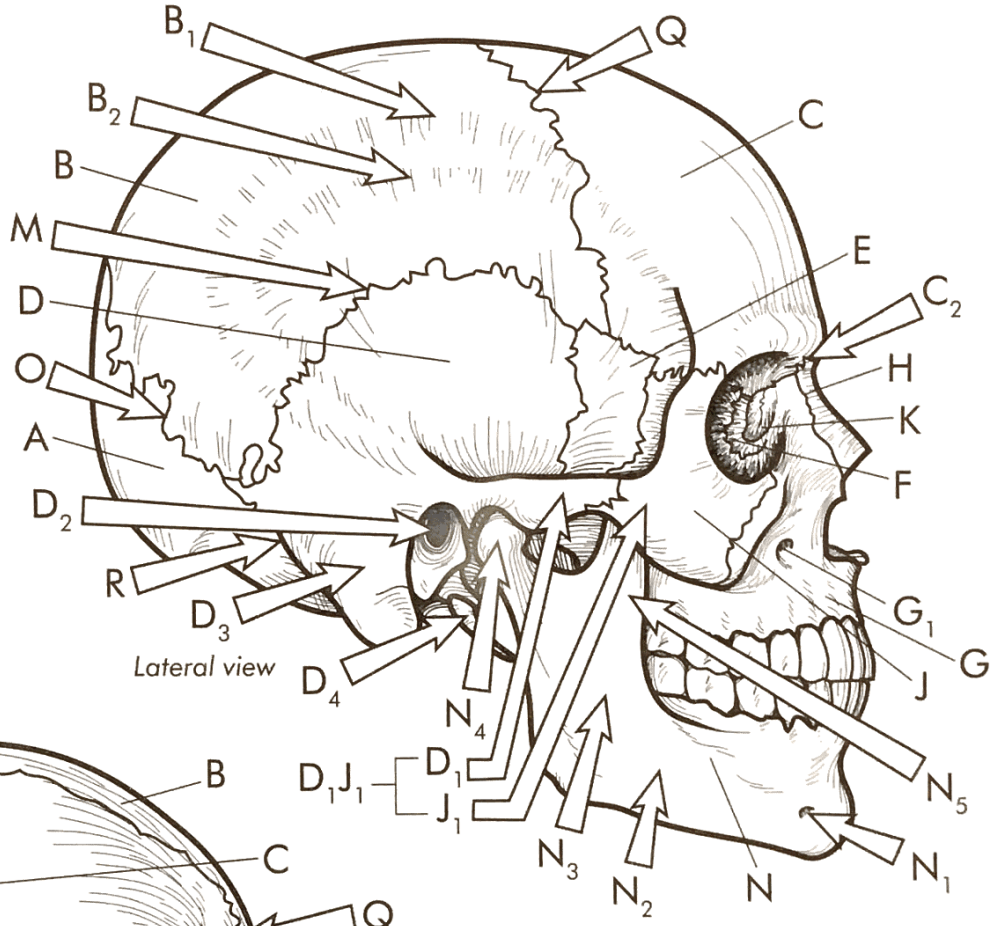
The tightly packed tissue of the diaphysis wall is **compact bone (I)**. This bone resists bending and is solid and strong. Compact bone is dense and appears smooth and homogenous. **Spongy bone (J)** is found primarily in the epiphyses. Spongy bone contains numerous branching, bony plates with irregular interconnected spaces. The spaces reduce the weight of the bone while maintaining strength. The plates are called **trabeculae (J_1)**. The spaces between the trabeculae contain red or yellow bone marrow.

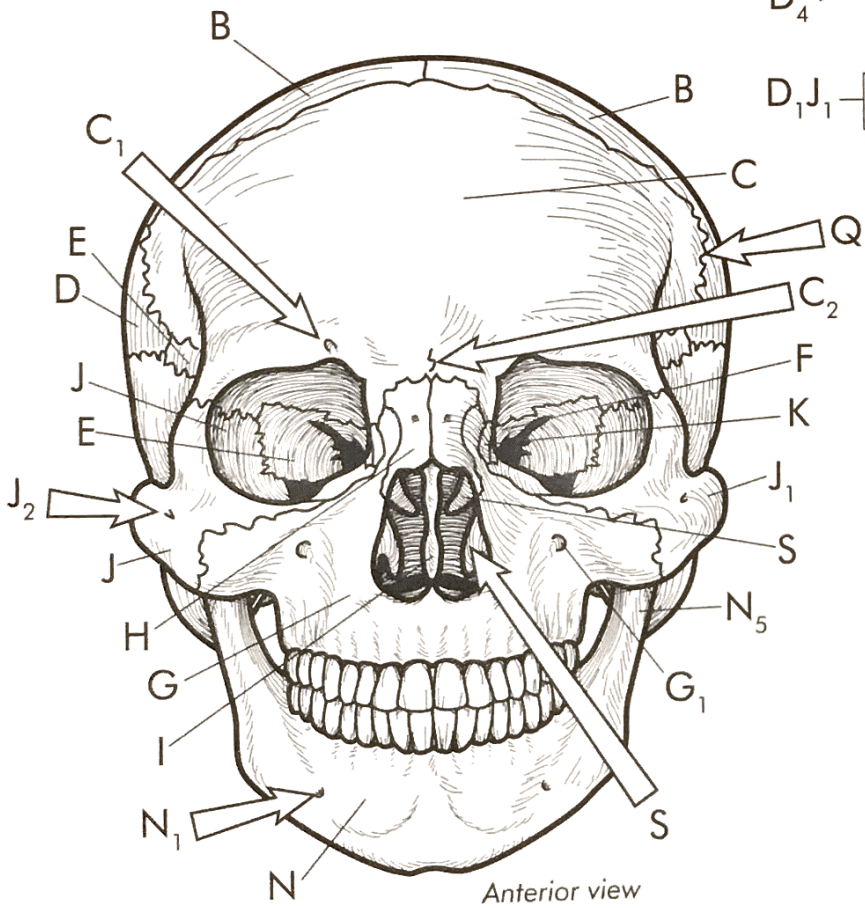
Complete the plate by exploring the medullary cavity, endosteum, and bone marrow. Prepare to color these structures as you read about them in the following paragraph. You may wish to use a red for the marrow and a lighter color for the medullary cavity.

The **medullary cavity (K)** is the central marrow cavity of the long bone. The cavity is continuous with the spaces of spongy bone at the epiphyses. The **endosteum (L)** is the membrane lining the medullary cavity. It contains cells related to bone development and breakdown. The space within the medullary cavity is filled with a specialized type of soft connective tissue called **bone marrow (M)**. The marrow consists primarily of blood cells and adipose cells. The marrow is yellow in the bone of adults. In young individuals, the marrow may be red because it is more involved in blood cell production.

THE SKULL—EXTERNAL SURFACE VIEW I

Occipital bone	A	○
Parietal bone	B	○
Superior temporal line	B_1	○
Inferior temporal line	B_2	○
Frontal bone	C	○
Supraorbital foramen	C_1	○
Glabella	C_2	○
Temporal bones	D	○
Zygomatic process	D_1	○
Zygomatic arch	D_1, J_1	○
External auditory meatus	D_2	○
Mastoid process	D_3	○
Styloid process	D_4	○
Sphenoid bone	E	○
Ethmoid bone	F	○
Maxilla	G	○
Infraorbital foramen	G_1	○





Nasal bones	H	○
Vomer bone	I	○
Zygomatic bone	J	○
Temporal process	J_1	○
Zygomatical facial foramen	J_2	○
Lacrimal bone	K	○
Squamosal suture	M	○
Mandible	N	○
Mental foramen	N_1	○
Body	N_2	○
Ramus	N_3	○
Condylar process	N_4	○
Coronoid process	N_5	○
Lambdoidal suture	O	○
Coronal suture	Q	○
Occipital mastoidal suture	R	○
Nasal concha	S	○

the SKULL— EXTERNAL SURFACE VIEW I

There are 22 bones making up the skull. The skull rests on the atlas of the vertebral column and surrounds the cranial cavity. Several smaller cavities called sinuses are also located within the skull, as are cavities housing the hearing and equilibrium structures. A number of foramena and fissures in the skull are the openings through which blood vessels and nerves pass into and out of the cranial cavity.

The skull is subdivided into cranial bones, which form the cranial cavity and enclose the brain, and the facial bones, which form the face. The facial bones also support passageways to respiratory and digestive systems, while providing attachments for the muscles of facial expressions. Moreover, the sense organs for taste, smell, touch, hearing, and equilibrium are protected and supported by the cranial facial bones.

The skull will be the subject matter of this plate and the two plates that follow. It will be examined according to its external surface in this and the following plate, and according to its internal surface in the third.

The structures and processes of the skull are found on this plate and the two that follow. Accordingly, you should try to use the same colors when completing the three plates. The letters associated with the skull structures are the same on all three plates to help you locate them and relate them to one another in various views. There will be seven views of the skull in the three plates. Light colors (such as pale shades of tan, gray, and yellow) should be used for the main bones, and care should be taken to avoid obscuring the arrows pointing to important processes of the bones. Begin the plate by coloring the title The Skull–External Surface View I. Then read the following paragraphs and, as you encounter the bone or process, color the plate in both the lateral and interior views. Separate directions will be given for each of the following plates.

The **occipital bone (A)** is a large bone forming much of the base of the cranium. This bone articulates in the anterior position with two bones: the parietal bone and the temporal bone. The **parietal bone (B)** is one of two paired bones that are large and curved and form most of the superior and lateral aspects of the skull. These bones form much of the cranial vault. A low ridge of each parietal bone is the **superior temporal line (B_1)**. This is the attachment site for the temporalis, one of the muscles involved in closing the mouth. The temporalis also attaches at the **inferior temporal line (B_2)**.

The dome-shaped bone at the forehead is the **frontal bone (C)**. This bone forms portions of the orbits of the eyes. The smooth portion of the bone between the orbits is known as the **glabella (C_2)**. The margin of the orbit contains a foramen called the **supraorbital foramen (C_1)**. This opening allows the supraorbital artery and nerve to pass into the region of the forehead.

The **temporal bones (D)** are inferior to the parietal bones and form portions of the lateral part of the skull as portions of the cranial floor. The temporal bone is the site of the **zygomatic process (D_1)**, which meets the **temporal process (J_1)** and helps form the **zygomatic arch (D_1, J_1)**. The bracket should be colored. This is the projection of the cheek, often called the cheekbone. The temporal bone also encloses the **external auditory meatus (D_2)**, also called the ear canal. Sound enters this opening and strikes the eardrum within. The mastoid region of the temporal bone contains the prominent **mastoid process (D_3)**. This is an attachment site for several neck muscles. Another prominent feature is the long, needle-like **styloid process (D_4)**. Several neck muscles attach here also. A ligament that secures the hyoid bone in the neck also attaches here.

You have now examined some of the bones of the cranial vault. We shall continue with some of the smaller but equally important bones. Continue as before, coloring the title of the bone or structure as you encounter it in the text, then color in the plate. When you encounter the bones of the eye orbit, use light colors because there are several small bones here. A complete picture of the skull will emerge as you color.

One of the most important bones of the cranial floor is the **sphenoid bone (E)**. This bone is somewhat shaped like a bat or a butterfly. It has a central body and several processes, which will be seen in a later plate. In the lateral and anterior views of the skull, the sphenoid bone can be seen at the skull surface, although it is not prominent. (It will be clearly seen in the internal view.) Another irregular bone forming part of the orbital wall is the **ethmoid bone (F)**. It is a deeply situated bone seen best in interior view, although portions can be seen at the lateral and anterior views shown here within the orbit of the eye.

The **maxilla (G)** is the upper jawbone composed of two bones (maxillae) fused to one another in the medial aspect. The maxilla carries the upper teeth and forms much of the hard palette, the bony roof of the mouth. A prominent process of the maxilla is the **infraorbital foramen (G_1)**. This is the site where the infraorbital artery and nerve enter the facial area.

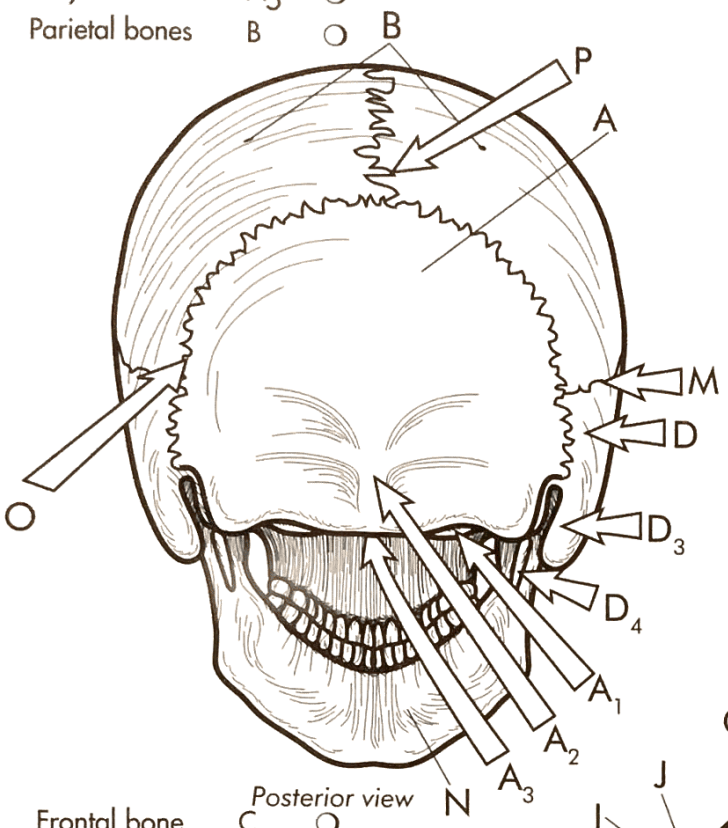
There are two **nasal bones (H)** that articulate with the frontal bone at the midline. At the lateral surfaces, the nasal bones articulate with the maxillae on either side. The **vomer bone (I)** is seen best in the internal surface of the skull. It has its base on the floor of the nasal cavity, and it forms the inferior portion of the nasal septum, as seen in the interior view on page 27. The portion of the vomer bone in this plate is thin. It separates the right and left nasal cavities. The **zygomatic bone (J)** is the cheekbone. Its **temporal process (J_1)** articulates with the zygomatic process of the temporal bone to form the prominent features of the cheeks, as we noted previously. Its **zygomatical facial foramen (J_2)** allows nerves to pass through. The zygomatic bone also forms a portion of the orbit of the eye and is seen clearly in the anterior and lateral views. Another bone of the orbit is the **lacrimal bone (K)**. This is the smallest bone of the skull and is difficult to see in these views.

The u-shaped **mandible (N)** forms the lower jawbone. It is the site of the **mental foramen (N_1)**, through which nerves pass from the chin and lips on their way to the brain. The main portion of the mandible is the **body (N_2)**, and the ascending portion is the **ramus of the mandible (N_3)**. The **condylar process (N_4)** is where the mandible articulates with the temporal bone. The **coronoid process (N_5)** is the site of the temporalis muscle, which also attaches to the parietal bones.

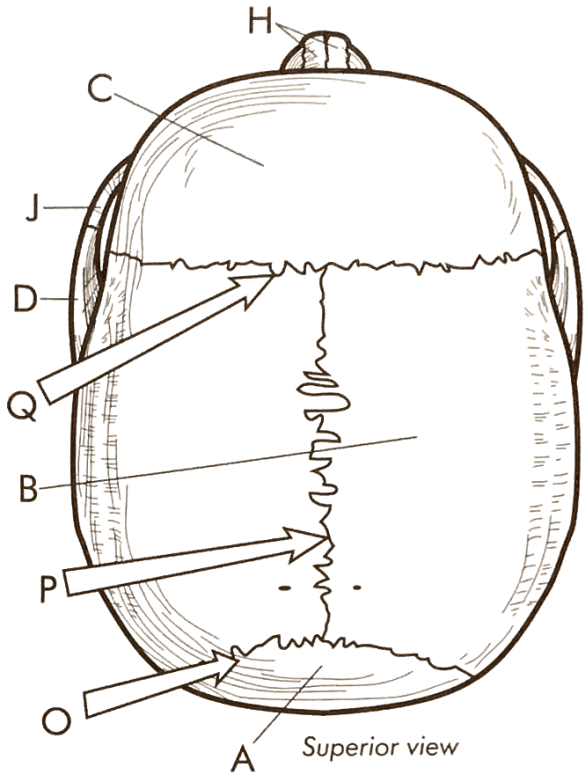
Where the skull bones meet, they form joints known as sutures. Dense fibrous connective tissue binds the bones together at these joints. One of the major sutures is the **squamosal suture (M)**. This suture occurs where the temporal and parietal bones articulate. A second suture is the **lambdoidal suture (O)**. This suture occurs at the junction of the occipital and parietal bones. A third suture seen in the anterior view is the **coronal suture (Q)**. This is the junction between the parietal bones and frontal bone at the top of the head. A minor suture known as the **occipital mastoidal suture (R)** lies at the junction of the occipital bone in the region of the mastoid process of the temporal bone. Tiny irregular bones called Wormian bones often occur in the sutures of the cranium. Their number varies, and they may not be present at all.

THE SKULL—EXTERNAL SURFACE VIEW II

Occipital bone	A	○
Occipital condyles	A_1	○
External occipital protuberance	A_2	○
Foramen magnum	A_3	○
Lateral foramen	A_4	○
Condyloid fossa	A_5	○
Parietal bones	B	○

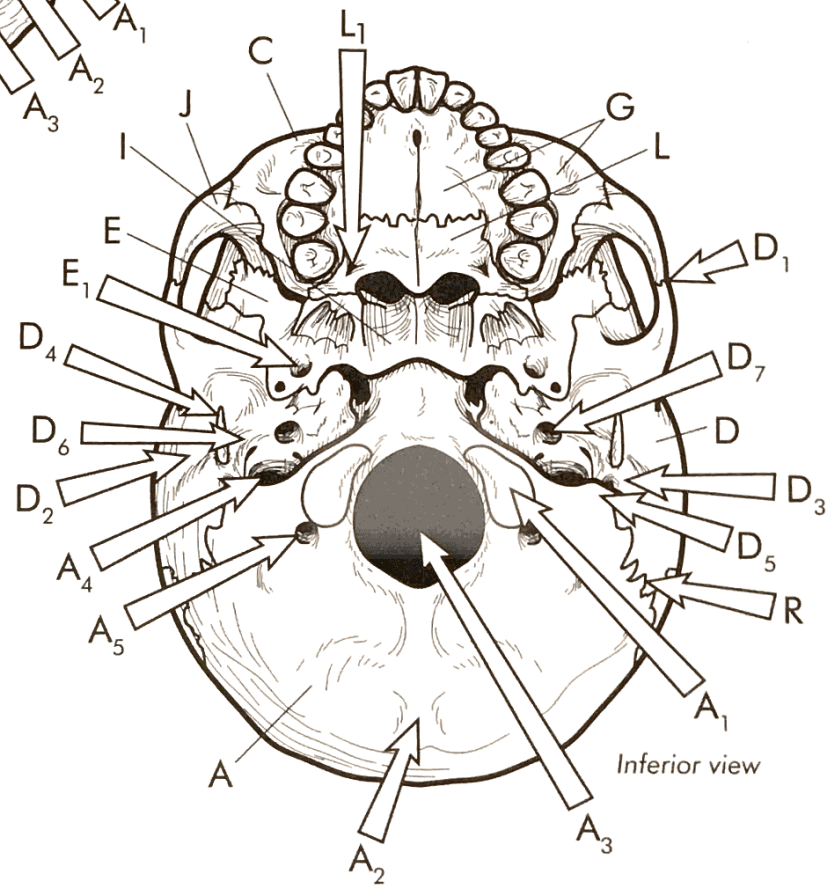


Posterior view



Superior view

Frontal bone	C	○
Temporal bone	D	○
Zygomatic process	D_1	○
External auditory meatus	D_2	○
Mastoid process	D_3	○
Styloid process	D_4	○
Stylomastoid foramen	D_5	○
Mandibular fossa	D_6	○
Carotid foramen	D_7	○
Sphenoid bone	E	○
Foramen ovale	E_1	○
Maxilla	G	○
Nasal bones	H	○
Vomer bone	I	○
Zygomatic bone	J	○
Palatine bones	L	○
Occipitomastoidal foramen	L_1	○
Squamosal suture	M	○
Mandible	N	○
Lambdoidal suture	O	○
Sagittal suture	P	○
Coronal suture	Q	○
Occipitomastoidal suture	R	○



Inferior view

the SKULL— EXTERNAL SURFACE VIEW II

The 22 bones of the human skull are grouped into the bones of the cranium (enclosing the brain), and the bones of the facial skeleton (making up the face). The cranial bones are the frontal, occipital, sphenoid, ethmoid, parietal (two bones), and temporal (two bones). The facial bones include the maxillae (two bones), zygomatic (two bones), nasal (two bones), lacrimal (two bones), palatine (two bones), inferior nasal conchae (two bones), vomer, and mandible. An examination of these bones began in the previous plate and continues in this plate. Here, the posterior, superior, and inferior views of the external surface of the skull are presented. In the previous plate, we began studies on the external surface. In this plate we will continue with views of the posterior, superior, and inferior views. If possible, you should use the same colors for the bones and processes as you used in the previous plate and will use in the following plate. The letters and designations for these bones and structures are identical in all three plates, so you can see the relationships and draw comparisons.

Begin this plate by coloring the main title The Skull—External Surface View II. Then note that the plate contains three views of the skull's external surface. As you locate the bones and processes in the following paragraphs, color them in all three views and try to get a sense of the three-dimensional structure of the skull. Lighter colors should be used for the main bones, and bolder colors can be used for the arrows pointing to the processes and landmarks.

On the posterior, lateral, and inferior surfaces of the cranium is the **occipital bone (A)**. A small portion may be seen in the superior view and a large portion in the inferior view. In the inferior view, the **occipital condyles (A_1)** are seen. These processes articulate with the atlas, the first vertebra of the vertebral column. At the midline of the occipital bone is the external **occipital protuberance (A_2)**. This is an attachment point for muscles, which stabilize the skull over the vertebral column. Ligaments also attach here. The **foramen magnum (A_3)** can be clearly seen as the large opening in the occipital bone through which the spinal cord passes on its way to the vertebral canal. At the **lateral foramen (A_4)**, the internal jugular vein passes and drains blood from the brain area. The **condyloid fossa (A_5)** is an attachment site for muscles.

The large bones at the superior and lateral portions of the cranial vault are the paired **parietal bones (B)**. The parietal bones articulate at an immovable joint called the **sagittal suture (P)**. In the superior view, the **frontal bone (C)** can be observed. The frontal bone articulates with the parietal bones at the **coronal suture (Q)**.

Continue the plate with an examination of the **temporal bone (D)**. Some of the processes are noted in the paragraph below, and the arrows pointing to them should be colored as you proceed. Darker blues, greens, and purples can be used for the arrows, but lighter colors should be used for the main bones.

The two temporal bones form the inferior lateral aspects of the cranium and part of the cranial floor. An important process of the lateral bone is the **zygomatic process (D_1)**. It articulates with the temporal process of the zygomatic bone to form the arch of the cheek. The **external auditory meatus (D_2)** opens to the eardrum and, behind the eardrum, the middle ear. The opening is part of the external ear. Posterior and inferior to the external auditory meatus is the **mastoid process (D_3)**. This rounded projection of the temporal bone is the point of attachment for several neck muscles. From the under surface of the temporal bone, the needlelike **styloid process (D_4)** projects. Tongue and neck muscles attach here. The **stylomastoid foramen (D_5)** is the opening through which the facial nerve passes to control activities of the facial muscles. Where the mandible articulates with the bone, the latter has a process called the **mandibular fossa (D_6)**. The **carotid foramen (D_7)** is the opening through which the internal carotid artery passes carrying blood to the brain. The **sphenoid bone (E)** and **foramen ovale (E_1)** are also visible.

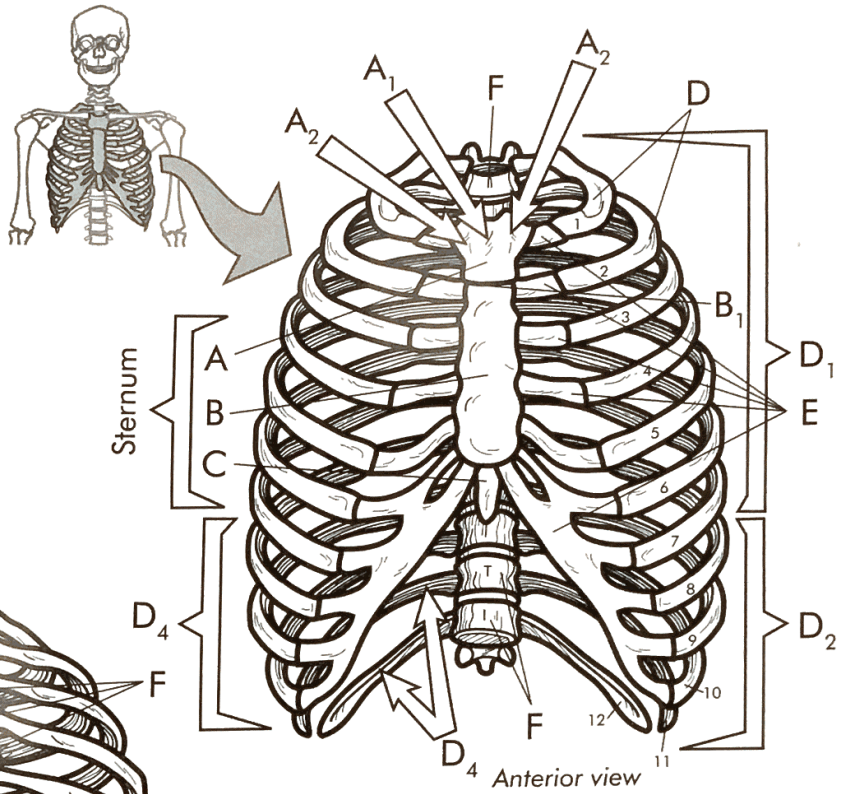
In the final section of this plate, some of the smaller bones of the skull are visible in posterior, superior, and inferior views. As you color these bones, use the same colors you used in the previous plate and will use in the following plate.

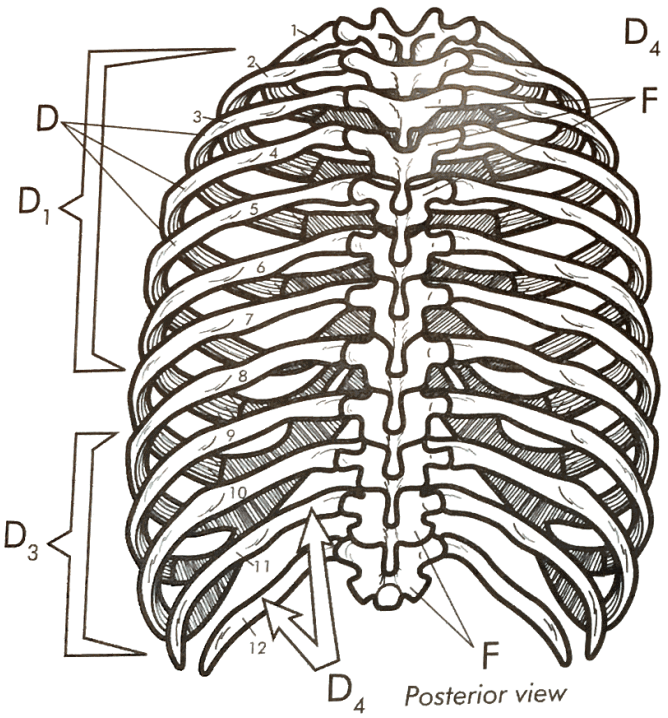
The **maxilla (G)** is formed from two maxillae and is the upper jawbone. It articulates with every facial bone except the mandible. With the **palatine bones (L)**, the maxillae form the hard palate. The **nasal bones (H)** are seen briefly in the superior view. The **vomer bone (I)** can be seen in the inferior view, and the **zygomatic bone (J)** is seen at the region of the cheek. In the inferior view, the palatine bone is observed at the roof of the mouth. It joins the maxillae to form the hard palate. An opening in the palatine bone is the **occipitomastoidal foramen (L_1)**. Nerves and blood vessels to the brain pass through this opening. The **mandible (N)** is also called the lower jawbone. It is seen in the posterior view only.

The final areas that we shall mention are immovable joints called sutures. The first is the **squamosal suture (M)**. This suture lies at the junction of the temporal and parietal bones and is seen in the posterior view. The second suture is a minor suture known as the **occipitomastoidal suture (R)**. It lies at the junction of the occipital bone in the region of the mastoid process of the temporal bone. This suture is prominently seen in the lateral view in the previous plate.

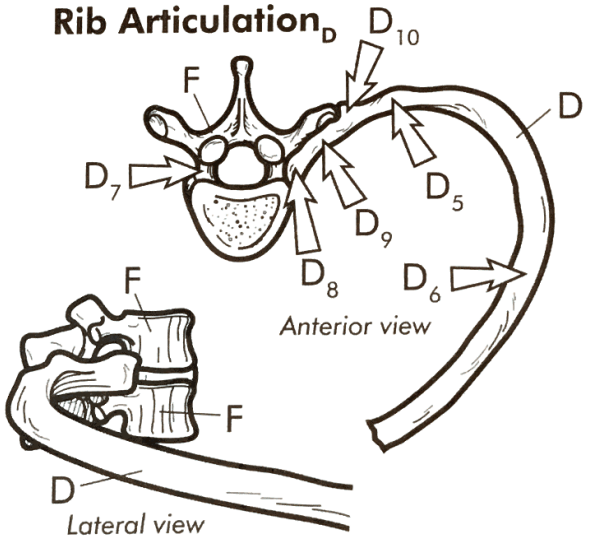
THE THORACIC CAGE AND HYOID BONE

Manubrium	A	○
Jugular notch	A_1	○
Clavicular notch	A_2	○
Body	B	○
Sternal angle	B_1	○
Xiphoid process	C	○
Rib	D	○
True ribs	D_1	○
False ribs	D_2	○
Vertebrochondral ribs	D_3	○
Floating ribs	D_4	○
Concave angle	D_5	○
Shaft	D_6	○
Demifacet	D_7	○
Capitulum	D_8	○
Neck	D_9	○



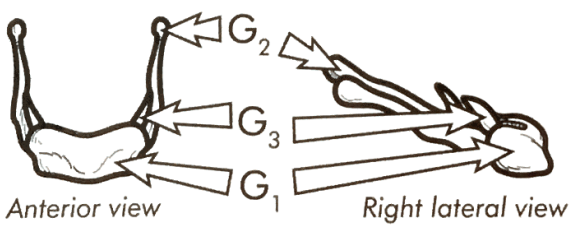


Rib Articulation$_D$



Tubercle	D_{10}	○
Costal cartilages	E	○
Vertebrae	F	○
Hyoid bone	G	○
Hyoid bone body	G_1	○
Greater horns	G_2	○
Lesser horns	G_3	○

The Hyoid Bone$_G$



the THORACIC CAGE and HYOID BONE

The chest cavity of the human body is known as the thorax. Surrounding this cavity is the skeleton of the chest, called the thoracic cage. The thoracic cage is formed in the dorsal aspect by the thoracic vertebrae, in the lateral aspect by the ribs, and in the anterior aspect by the sternum and costal cartilages, which bind the ribs to the sternum.

The thoracic cage has the basic shape of a cone, with its narrow dimension in the superior aspect and its broad dimension in the inferior aspect. The cage protects the important organs of the thoracic cavity such as the heart and lungs; it provides support for the pectoral girdles and upper limbs; it is an attachment point for many muscles of the chest, back, and shoulders; and it functions in breathing as the intercostal spaces between the ribs lift when inhaling and depress when exhaling.

Start by coloring the main title The Thoracic Cage and Hyoid Bone. Then note that the plate contains views of the thoracic cage from the anterior and posterior aspects. In the first two sections of the plate, Sternum and Rib, you should color the structures and bones in both the anterior and posterior views as you read about them. The section Rib Articulation is discussed later, and your coloring on this section can be delayed for the time being. Now color the main title Sternum and begin your study of the sternum. As you encounter the bones and processes of the sternum, color them in on the plate. Use lighter colors for the bones (especially the ribs) because the thoracic cage is somewhat complex, and try not to obscure the markings.

The sternum is the breastbone of the body. It lies in the anterior midline of the thorax and is seen only in the anterior view. The sternum has the outline of a dagger and consists of three bones fused together. These bones are designated A, B, and C in the plate, and the bracket indicating the sternum should be colored with a dark color.

The superior portion of the sternum is the **manubrium (A)**, the widest portion of the sternum. It contains a **jugular notch (A_1)**, which is a shallow indentation where the left common carotid artery emerges from the aorta The **clavicular notch (A_2)** is the point where the clavicles articulate with the sternum. Below the clavicular notch is an articular facet for the costal cartilage of the first rib.

The second bone of the sternum is the middle and largest portion, the **body (B)**. The body develops from four separate segments, indicated by a number of transverse ridges on the anterior surface. The costal cartilages from ribs three through seven attach to the body. The second rib articulates where the body meets the manubrium, a distinctive anatomical landmark called the **sternal angle (B_1)**.

The smallest portion of the sternum at the inferior aspect is the **xiphoid process (C)**. It is an attachment site for two important muscles, the diaphragm and the rectus abdominis. The xiphoid process varies considerably in size and shape among adults.

Continue your work on the plate by coloring the title **Rib (D)**. Then, color all the ribs of the anterior and posterior view using the same light color you used on the thoracic cage. Be careful, however, not to color the costal cartilages yet. When you have finished, read about the ribs below, and complete the anterior and posterior views of the thoracic cage.

The ribs are curved, elongated bones originating at the thoracic vertebrae and terminating in the anterior wall of the thoracic cage. They are divided into different groups depending upon their structure: the first seven pairs of ribs are the **true ribs (D_1)**, the brackets for these ribs should be colored in the anterior and posterior views. The true ribs are called this because they are connected directly to the sternum by **costal cartilages (E)**. The costal cartilages of the true ribs should be colored now. The second set of ribs are the **false ribs (D_2)**. The false ribs do not attach directly to the sternum and are ribs eight through twelve. The bracket encompassing these ribs should be colored now. The false ribs are further subdivided into vertebrochondral ribs and floating ribs. The **vertebrochondral ribs (D_3)** are ribs eight, nine, and ten. These ribs fuse together by costal cartilages before reaching the sternum. Ribs eleven and twelve are called **floating ribs (D_4)** because they have no connection to the sternum. Note in the posterior view how the ribs are attached to the **vertebrae (F)**. The vertebrae may be colored at this point to complete the anterior and posterior views of the thoracic cage.

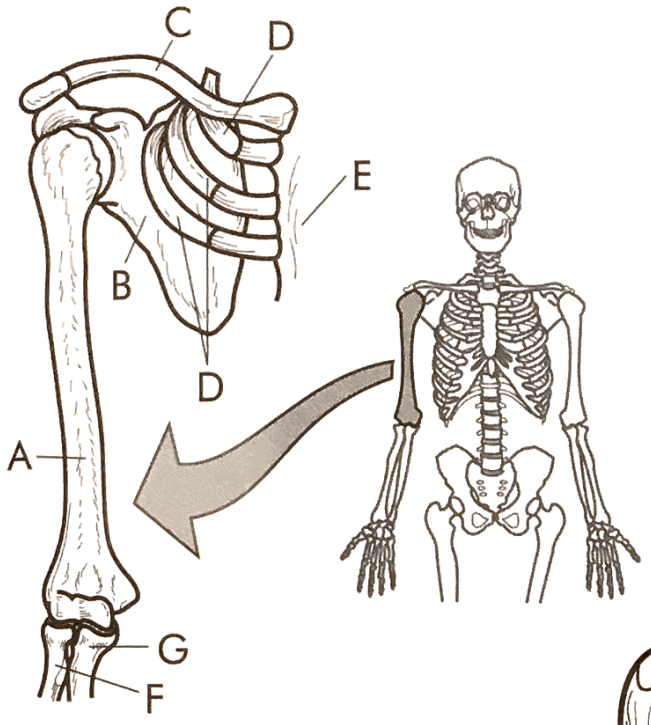
The third section of this plate shows the rib and its articulation. Begin the section by coloring the title Rib Articulation. Then notice in the plate that two views are shown: a superior view and a lateral view. In the superior view, color the thoracic **vertebra (F)** using a light color. Try to use the same color that you used in the anterior and posterior views. Then, in the lateral view, color the two thoracic vertebrae. Now color the **rib (D)** using the same light color you used above. Try to avoid obscuring the details of its processes. Then read about the rib and its articulation below, and color the arrows leading to the processes as you encounter them.

The "typical" rib is difficult to define because variations occur in the 12 pairs of ribs. However, ribs three through nine have distinguishing features in common. The rib has a **concave angle (D_5)**, which occurs along the body, or **shaft (D_6)** of the rib. The rib originates at a **demifacet (D_7)** of the thoracic vertebra. Articulating with the demifacet is the head, or **capitulum (D_8)** of the rib. The **neck of the rib (D_9)** follows the capitulum. Lateral from the capitulum is a projection called the **tubercle (D_{10})**. A portion of the tubercle contains the facet that articulates at the transverse process of the vertebra. These two articulations are seen in the lateral view, which also illustrates how the rib articulates at the point where two thoracic vertebrae meet. The facet of the capitulum fits into two demifacets of two adjoining vertebrae, while the articular portion of the tubercle articulates with a facet of the transverse process.

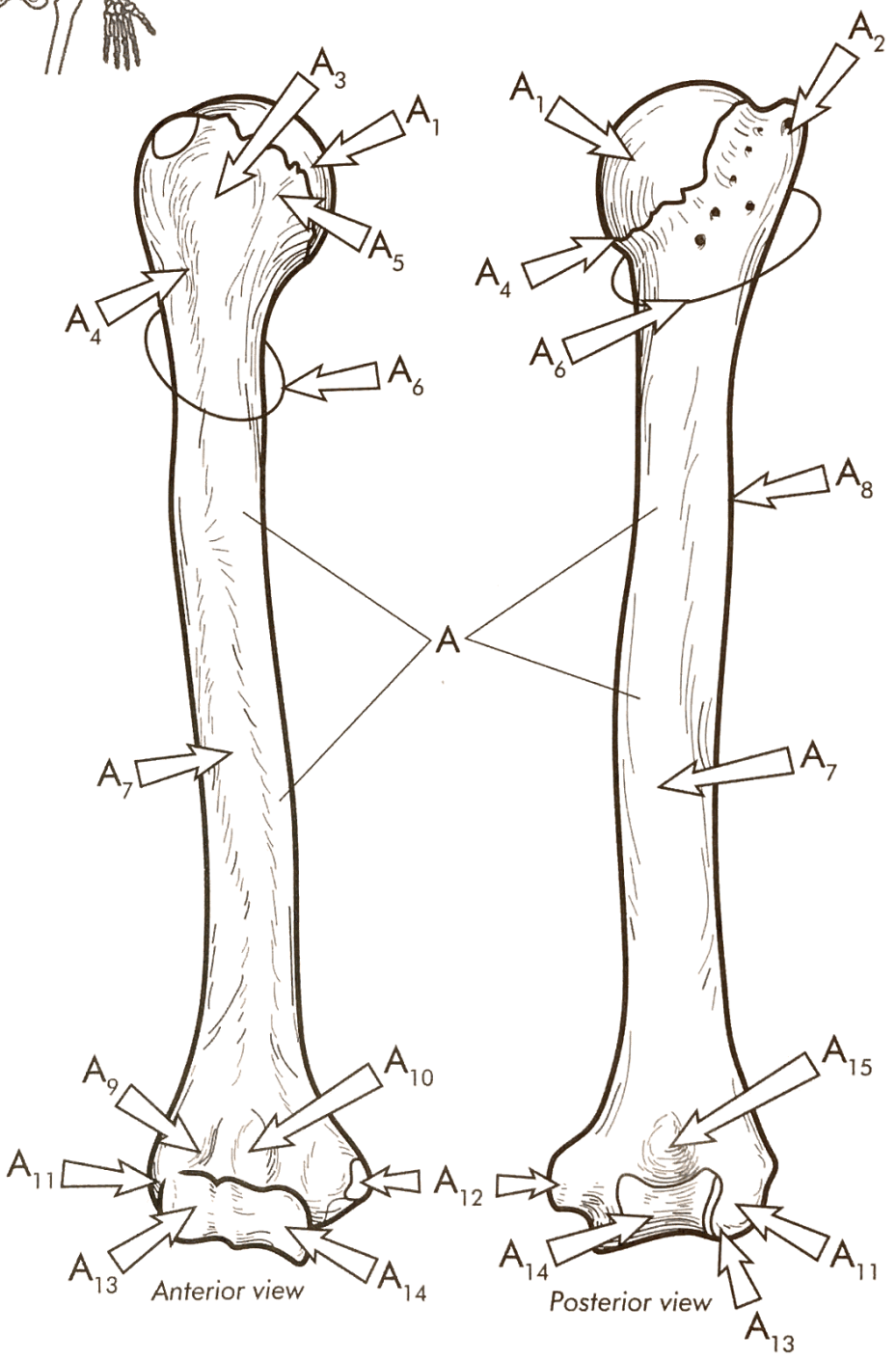
The spaces between the ribs are known as intercostal spaces. Blood vessels, nerves, and intercostal muscles occupy these spaces. The muscles contract and permit expansion of the thoracic cavity during inhalation, then relax and permit depression of the cavity during exhalation.

Now complete the plate by examining the hyoid bone. Color its title, then color the bone in a light color and its processes in darker colors as you continue your reading.

The **hyoid bone (G)** is unique because it does not articulate with any other bone. The hyoid bone is located in the neck tissues. Ligaments and tendons suspend it from the styloid process of the temporal bone. Its features include the **body (G_1)**, the **greater horns (G_2)**, and the **lesser horns (G_3)** The horns are also called cornua. Many neck and pharyngeal muscles attach to the bone.



Humerus	A	○
Head	A_1	○
Greater tubercle	A_2	○
Lesser tubercle	A_3	○
Intertubercular groove	A_4	○
Anatomical neck	A_5	○
Surgical neck	A_6	○
Shaft of the humerus	A_7	○
Deltoid tuberosity	A_8	○
Radial fossa	A_9	○
Coronoid fossa	A_{10}	○
Lateral epicondyle	A_{11}	○
Medial epicondyle	A_{12}	○
Capitulum	A_{13}	○
Trochlea	A_{14}	○
Olecranon fossa	A_{15}	○
Scapula	B	○
Clavicle	C	○
Ribs	D	○
Sternum	E	○
Radius	F	○
Ulna	G	○



the UPPER EXTREMITY/the HUMERUS

The humerus, also known as the upper arm bone, is the largest and longest bone of the upper extremity. It is a relatively thick bone with a large, smooth head at the proximal end and a number of projections (processes) at the distal end. Sixty bones are found in both the upper and lower extremities.

Begin this plate by coloring the main title The Upper Extremity/The Humerus, and then color the title The Humerus In Place. Now examine this section of the plate and color in the main features of the upper limb as you encounter them in the reading below. The humerus should be colored a light color such as pale blue, but the other bones can be darker.

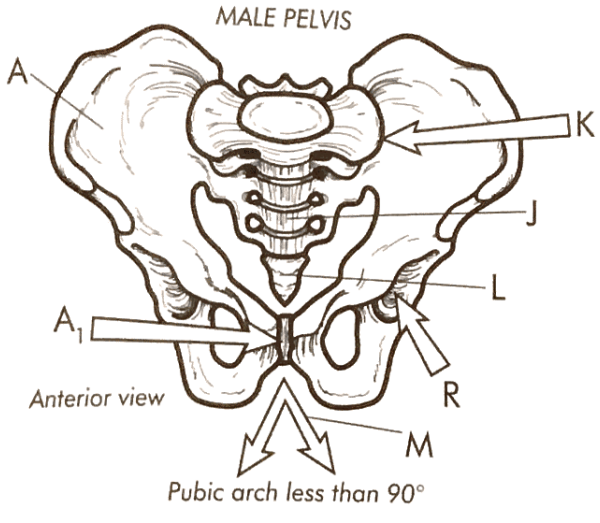
The **humerus (A)** is the main bone of the upper extremity. It articulates with the **scapula (B)** at the glenoid fossa. Another prominent bone in this area is the **clavicle (C)**. The nearby bones to the pectoral girdle include the **ribs (D)**, which articulate with the **sternum (E)**. Distally, the humerus articulates with the **radius (F)** and the **ulna (G)**; these are described in the next plate.

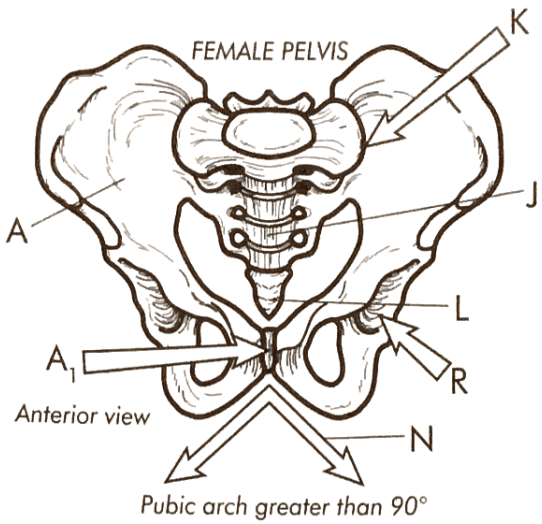
The remainder of the plate shows the important processes of the humerus. Color in the title Processes of the Humerus. The humerus in both anterior and posterior views should be colored in the same light color used previously. (A light color is recommended so that the important processes are not obscured.) As you read about the processes in the following paragraphs, locate them and color their arrows in both the anterior and posterior views. Some processes are present on the anterior aspect but not on the posterior aspect, and vice versa.

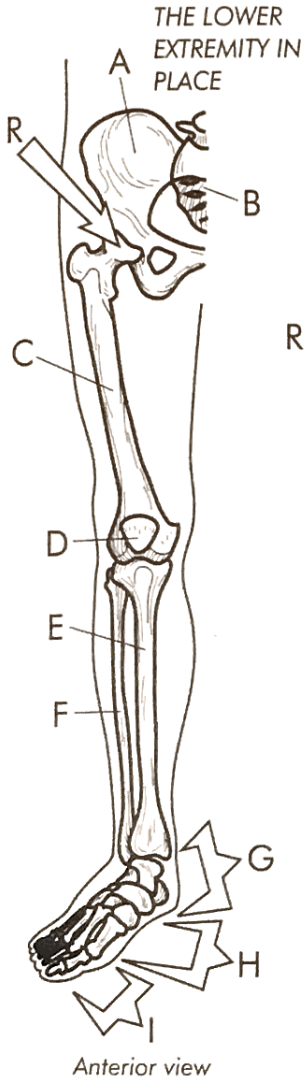
Beginning at the proximal end, the humerus features a **head** (A_1) that articulates at the glenoid cavity of the scapula. The head is prominent in the posterior view, and both anterior and posterior arrows should be colored at this time. On the lateral surface of the epiphysis of the humerus is the **greater tubercle** (A_2). This is an attachment point for shoulder joint ligaments and is the most lateral point of the shoulder region that can be felt through the skin. The **lesser tubercle** (A_3) is also an attachment point for ligaments. It lies on the anterior and medial surface of the humerus. A groove called the **intertubercular groove** (A_4) separates the greater and lesser tubercles. The **anatomical neck** (A_5) is the distal limit of the articular capsule. It is the site of what once was the epiphyseal plate. The **surgical neck** (A_6) is a constricted portion distal to the tubercles and a common site of fractures.

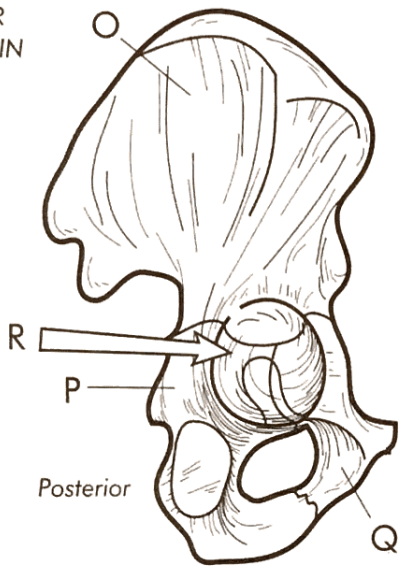
Continue with the plate by focusing on the shaft and distal portion of the humerus. As you encounter the structures in the paragraphs below, color the titles and arrows that point to the appropriate processes and landmarks. Dark colors may be used for the arrows to contrast with the light color of the bone.

The **shaft of the humerus** (A_7) is rounded at the proximal end, but more triangular at the distal end. An important process on the shaft is the **deltoid tuberosity** (A_8). This is where the deltoid muscle (the fleshy mass of the shoulder) attaches to the humerus. The tuberosity is shaped like a V. At the distal end of the bone is a depression called the **radial fossa** (A_9). The head of the radius articulates here when the arm is flexed. The **coronoid fossa** (A_{10}) is the depression that receives the ulna's coronoid process during flexion. The **lateral epicondyle** (A_{11}) is an attachment site for muscles that move the forearm. The **medial epicondyle** (A_{12}) is a second attachment site for these muscles. The **capitulum** (A_{13}) is seen prominently in the anterior view. It is a "little head" that articulates with the radius. The **trochlea** (A_{14}) is a point of articulation with the ulna. The posterior view of the humerus shows the **olecranon fossa** (A_{15}). This is a depression that receives the olecranon process of the ulna during extension of the forearm.

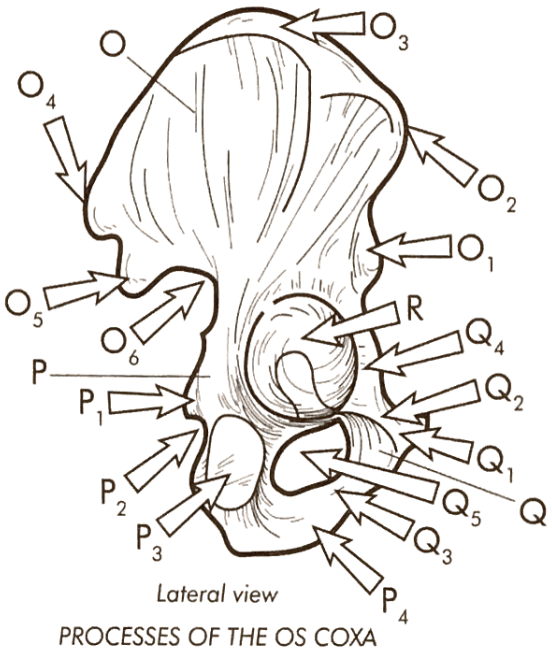








BONES OF THE OS COXA



PROCESSES OF THE OS COXA

Pelvic bone	A	○	Anterior superior iliac spine	O_2	○
Pubic symphysis	A_1	○	Iliac crest	O_3	○
Sacrum	B	○	Posterior superior iliac spine	O_4	○
Femur	C	○	Posterior inferior iliac spine	O_5	○
Patella	D	○	Greater sciatic notch	O_6	○
Tibia	E	○	Ischium	P	○
Fibula	F	○	Ischial spine	P_1	○
Tarsals	G	○	Lesser sciatic notch	P_2	○
Metatarsals	H	○	Ischial tuberosity	P_3	○
Phalanges	I	○	Ramus of the ischium	P_4	○
Sacrum	J	○	Pubis	Q	○
Sacroiliac joint	K	○	Pubic tubercle	Q_1	○
Coccyx	L	○	Superior ramus	Q_2	○
Male pubic arch	M	○	Inferior ramus	Q_3	○
Female pubic arch	N	○	Body of the pubis	Q_4	○
Ilium	O	○	Obturator foramen	Q_5	○
Anterior inferior iliac spine	O_1	○	Acetabulum	R	○

the LOWER EXTREMITY/the PELVIC GIRDLE

The pelvic girdle, also called the hip girdle, attaches the lower extremity to the axial skeleton. It transmits the upper body weight to the lower limbs while supporting the visceral organs of the pelvis. Because the pelvic girdle is secured to the axial skeleton by strong ligaments, movement at the hip joints is not as great as at the shoulder joint. Moreover, the sockets of the lower extremity are heavily reinforced by ligaments, also limiting the degree of freedom at the hip joint.

The pelvic girdle encircles the body and provides an attachment point for the lower extremity. Begin the plate by coloring in the main title The Lower Extremity/The Pelvic Girdle. Then color in the title, The Lower Extremity In Place. Examine this part of the plate, and as you read about the structures of the lower extremity, color their titles and structures. Dark colors may be used for contrast since there are few processes to point out. However, you should use a light color for the pelvic bone since it will be explained in detail below.

The pelvic girdle is formed by two bones called os coxae. The coxal bones unite with one another in the anterior aspect and with the sacrum in the posterior aspect. They form a deep basinlike structure called the pelvis. With the lower extremity in place, the **pelvic bone (A)** can be seen articulating with the **sacrum (B)**. The thigh bone (known as the femur) articulates with the pelvic bone at a cuplike socket called the **acetabulum (R)**. Distally, the femur articulates with the kneecap or **patella (D)** and the large leg bone known as the **tibia (E)**. Lateral to the tibia is the smaller leg bone known as the **fibula (F)**. The ankle bones are the **tarsals (G)**, and the bones of the foot are the **metatarsals (H)**. The toe bones are the **phalanges (I)**.

We will now examine the structure of the pelvic girdle and os coxae more closely by noting the difference between the male and female pelvis. Begin coloring this portion of plate by coloring the titles Male and Female Pelvis. Then read below and examine the differences between the two.

Differences between the male pelvis and female pelvis are clear and striking. Indeed, a trained anatomist can determine the sex of a skeleton by examining the pelvis. Each pelvis has similar **pelvic bones (A)**. The **acetabulum (R)** is visible in each pelvis. The pelvic bones articulate with the **sacrum (J)** at a joint called the **sacroiliac joint (K)**. Posterior to the sacrum is the **coccyx (L)**, the last vertebra. The **male pelvis** has a **pubic arch** less than 90° **(M)**. By contrast, the **pubic arch** of the **female pelvis** is greater than 90° **(N)**. Thus, the female pelvis is wider, shallower, and rounder than the male pelvis. This allows the female to accommodate the growing fetus, and it permits the infant to exit through the pubic bones at birth. The bones separate at a point called the **pubic symphysis (A_1)**. This is the point where the os coxae come together in the anterior aspect.

Continue the plate with two lateral views of the os coxa. Begin by coloring the titles Bones of the Os Coxa and Processes of the Os Coxa. First you will examine the components of the pelvic girdle, then learn some of its important processes. The figure of the bones (the first one) should be colored in darkly so you can see their relationships, but light colors such as pale red, green, and blue should be used for the processes figure so as to avoid obscuring the arrows. Read the paragraph below as you continue and color in the titles and processes as you proceed.

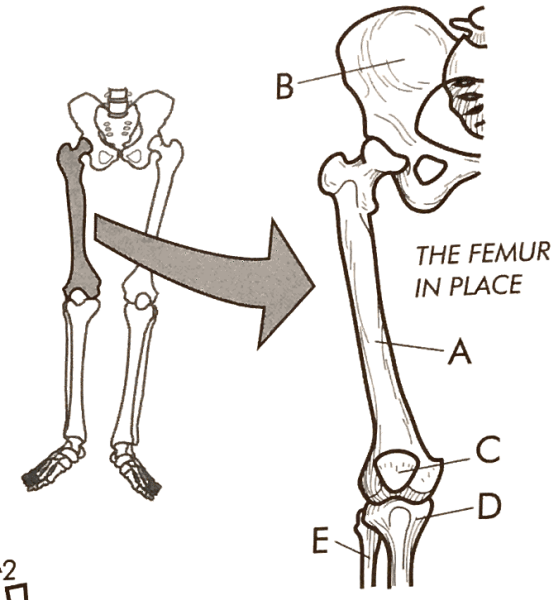
After birth and during early childhood, each os coxa consists of three separate bones. These bones are the **ileum (O)**, the **ischium (P)**, and the **pubis (Q)**. By the adult years, these bones have fused firmly to one another and their boundaries cannot be distinguished. However, their names are retained for reference to different portions of the pelvic bone. Processes therefore include the names of the three bones. Each of the three bones contributes to the formation of the cuplike **acetabulum (R)** seen on the lateral surface.

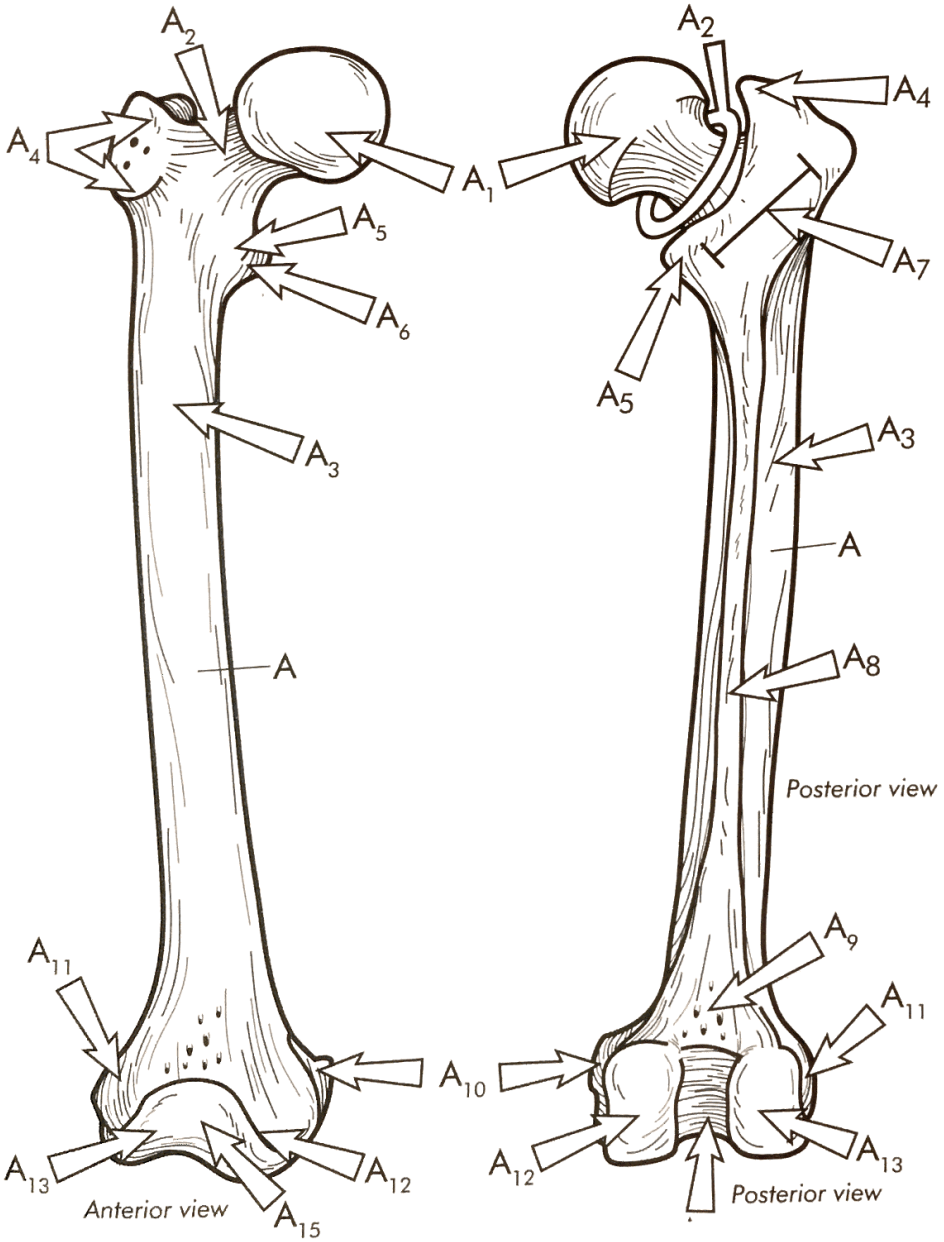
We shall begin noting the processes of the os coxa and focus on those of the ileum. In the anterior aspect, the expansion of the ileum begins with the **anterior inferior iliac spine (O_1)**. This is an attachment point for hip, thigh, and trunk muscles. This spine is palpable through the skin. Next is the **anterior superior iliac spine (O_2)**, which is another muscle attachment point. Curving posteriorly is the **iliac crest (O_3)**. This ridge is an attachment point for ligaments and muscles of the abdomen and leg. The iliac crest extends to the **posterior superior iliac spine (O_4)**. The margin continues as the **posterior inferior iliac spine (O_5)**, which is also a muscle attachment site. Inferior to the posterior inferior iliac spine, the ileum indents deeply and forms the **greater sciatic notch (O_6)**. This is the place through which the sciatic nerve passes. The sciatic nerve is the longest nerve of the body and it enters the thigh.

We shall complete the plate by focusing on the important markings and processes of the ischium and pubis. Watch for the arrows associated with the processes and color them in dark colors.

Posterior to the acetabulum is the **ischial spine (P_1)**. The ischial spine can be palpated by the physician through the vaginal wall and is used for determining pelvic measurements during childbirth. The lesser **sciatic notch (P_2)** is the site where a number of nerves and blood vessels pass to the perineum, which is the anogenital region. The inferior surface is thickened as the **ischial tuberosity (P_3)**. When sitting, the body's weight is placed on the ischial tuberosity, the strongest part of the pelvic girdle. The **ramus of the ischium (P_4)** joins the pubis in the anterior aspect. The pubis, also called the pubic bone, is the major portion of the anterior os coxa. At the lateral end is the **pubic tubercle (Q_1)**, which is an attachment site for the important inguinal ligament. Essentially the pubis is a V-shaped bone with a **superior ramus (Q_2)** and the **inferior ramus (Q_3)**. Near the superior and inferior rami of the pubis is the **body of the pubis (Q_4)**. The pubic rami and the rami of the ischium form the **obturator foramen (Q_5)**. Collagen fibers enclose this space, and the inner and outer surfaces of the foramen are used as attachment sites for various muscles. A few blood vessels and nerves pass through this foramen and enter the thigh. Portions of the pubis, ilium, and ischium form the **acetabulum (R)**.

Femur	A	○	Medial epicondyle	A_{10}	○
Head of femur	A_1	○	Lateral epicondyle	A_{11}	○
Neck of femur	A_2	○	Medial condyle	A_{12}	○
Shaft of femur	A_3	○	Lateral condyle	A_{13}	○
Greater trochanter	A_4	○	Intercondylar fossa	A_{14}	○
Lesser trochanter	A_5	○	Patellar space surface	A_{15}	○
Intertrochanteric line	A_6	○	Pelvic girdle	B	○
Intertrochanteric crest	A_7	○	Patella	C	○
Linea aspera	A_8	○	Tibia	D	○
Popliteal surface	A_9	○	Fibula	E	○





the LOWER EXTREMITY/ the FEMUR

Each lower limb has the same number of bones as the upper limb: 60. The lower limb is divided into several regions, with the thigh extending from the hip joint to the knee. The thigh contains a single bone called the femur. Other regions, known as the leg, ankle, and foot, are considered in plates following this one.

Color in the main title The Lower Extremity/The Femur. Now color in the title The Femur In Place. Then read the paragraph below, and when you encounter the bone, color its title in the titles list and in the plate. Use a light color for the femur and darker colors for the other bones in the figure entitled The Femur In Place.

The thighbone is anatomically known as the **femur (A)**. It is the longest, heaviest, and strongest bone in the body. At the proximal end it articulates with the hipbone, technically known as the **pelvic girdle (B)**. The femur then courses medially and descends toward the knee. At the distal end, it articulates with the **patella (C)** and the **tibia (D)**. The second bone of the leg, the **fibula (E)**, is nearby but does not articulate with the femur. The femur is covered by strong and bulky muscles that permit it to endure the stress placed on the bone. The length of the femur is about one-quarter of a person's height.

Look over the list of processes associated with the femur, but do not color them yet. Instead, wait until you encounter the process in the reading below. At that point, color the arrow pointing out the process in both the anterior and posterior views. Certain processes will be present on only one of the views. You should begin by coloring the femur itself in a light color (as used above) so as not to obscure the arrows pointing out the important processes. Both the anterior and posterior views of the femur can be colored before you begin your study of its processes.

At its proximal end, the femur contains a rounded epiphysis known as the **head** (A_1). The head articulates with the pelvic bone at the hip joint, which is called the acetabulum. The view of the femur in place shows this articulation. A small central pit called the fovea capitis is at the center of the head. This is a point of attachment for ligaments. The head of the femur is found on a **neck** (A_2). The neck angles to the lateral aspect and joins the **shaft** (A_3) of the femur. Fractures often occur at the neck of the femur, especially when bone degradation has taken place. The condition is often called a broken hip. Projecting laterally where the neck and shaft join is the **greater trochanter** (A_4). This is a point of attachment for several muscles of the thigh and pelvic region. Prominently on the posterior aspect is the **lesser trochanter** (A_5), which is also an attachment point for various muscles. On the anterior aspect of the femur is a raised area called the **intertrochanteric line** (A_6). This region connects the greater and lesser trochanters. On the posterior surfaces is the **intertrochanteric crest** (A_7). This ridge also connects the trochanters. A ridge below in the intertrochanteric crest is the gluteal tuberosity, a point of attachment for several thigh muscles.

At this point, you have completed a study of the proximal end of the femur. The remainder of the plate deals with structures at the distal end. Look over the remaining markings and processes of the femur and as you encounter them in the reading below, color the arrows pointing out the processes.

Continuing from the gluteal tuberosity, the posterior surface of the femur contains a vertical ridge called the **linea aspera** (A_8). This is the site of muscles that bring about abduction of the thigh. Except for this ridge, the shaft of the femur is smooth and round. At the distal end, the femur is constructed to permit articulation with the femur. The linea aspera divides to form a flattened, triangular area called the **popliteal surface** (A_9). This is the point of attachment of the popliteal muscle. On the medial surface is the **medial epicondyle** (A_{10}) where several muscles attach. On the opposite surface is the **lateral epicondyle** (A_{11}), which is also a site of muscle attachment. Also on the medial surface is the **medial condyle** (A_{12}). This is a point of articulation with the tibia. The **lateral condyle** (A_{13}) is a second point of articulation. The depressed area between the condyles on the posterior surface is the **intercondylar fossa** (A_{14}). On the anterior surface is a smooth area called the **patellar space surface** (A_{15}). This area is located between the condyles and is the point of articulation with the patella, also called the knee cap. The patella glides over this smooth surface.