1. Demonstrate on a skeleton the motions that occur at the metatarsophalangeal joints and interphalangeal joints of the foot.

2. Palpate on the cadaver:
   a. medial malleolus
   b. lateral malleolus
   c. heads of the metatarsals
   d. tuberosity of the fifth metatarsal
   e. proximal, middle, and distal phalanges

3. Place a probe under the deep peroneal nerve and anterior tibial artery at the front of the ankle. Be careful to preserve this nerve and artery as dissection progresses.

4. Excise the superior extensor retinaculum (transverse crural ligament) as needed to see tendons, nerve, and artery entering the ankle region. Leave one narrow strip of the retinaculum intact for later study.

**NOTE TO THE DISSECTOR**

On the dorsum of the foot, the dorsal venous arch should be preserved. The great saphenous vein originates at this arch, then enters the medial aspect of the leg. On the lateral side of the arch, a network of veins emerge to form the small saphenous vein, which will pass into the posterior leg to enter the popliteal region. Save the dorsal venous arch, leaving it attached by pieces of fascia to the dorsum of the foot. Tributaries may be clipped.

5. Make a midline incision from the ankle to the level of the metatarsophalangeal joint of the middle toe (Figure 21.1). A transverse incision should then be made at the level of the metatarsophalangeal joints. Remove skin, keeping the skin flap in one piece.

6. Preserve cutaneous branches of the superficial peroneal nerve on the dorsal surface of the foot.

7. Locate the **dorsal venous arch** and leave it attached to fascia on the dorsum of the foot. Tributaries may be clipped.

8. Identify the inferior extensor retinaculum. This will need to be excised because it will block viewing of muscles and nerves in the foot.
9. Note the position of each tendon in relation to the other tendons as they pass across the ankle joint and enter the foot. Figure 21.2.

10. Locate the distal insertion of each of the following muscles Figure 21.2:
   a. tibialis anterior
   b. extensor hallucis longus
   c. extensor digitorum longus
   d. peroneus tertius (fibularis tertius)

   Pull on the tendon of each of these muscles to study the action accomplished.

11. Locate the tendons of the peronei longus and brevis. Note that the tendons of the peronei longus and brevis pass under the peroneal retinacula as they cross the lateral side of the foot. Leave a small strip of the peroneal retinacula intact for later study.

12. The insertion of the peroneus brevis on the tuberosity of the fifth metatarsal can be seen. Note that the peroneus longus continues around the lateral side of the cuboid to cross the plantar surface of the foot. The insertion of the peroneus longus will be viewed when the sole is dissected (Chapter 23). Pull on the tendons of the peronei longus and brevis to compare and contrast their actions.

13. Identify the extensor digitorum brevis. The medial portion of this muscle with a tendon to the great toe is frequently referred to as the extensor hallucis brevis. Locate
the proximal attachment of the extensor digitorum brevis and follow each of its tendons to the appropriate insertion Figure 21.2.

14. Trace the deep peroneal nerve on the dorsum of the foot. Find a branch innervating the extensor digitorum brevis. Another branch of this nerve continues into the first interosseous space where it divides into cutaneous nerves supplying the lateral side of the great toe and the medial side of the second toe.

15. The dorsalis pedis artery continues on the foot to the first interosseus space, where it gives off several branches. Locate the dorsalis pedis artery.

16. Remove skin from the dorsum of the great toe and the first lateral toe. DO NOT save the skin but cover the foot with a sock at the completion of each lab period.

NOTE TO THE DISSECTOR  It is best to use a white tube sock to prevent dye from leaking into the tissue of the cadaver.

17. Identify:
   a. insertion of the extensor hallucis longus
   b. insertion of the extensor digitorum longus
   c. insertion of the extensor digitorum brevis

18. Locate the dorsal interossei between metatarsal bones. The insertions of dorsal and plantar interossei will be traced after dissection of the sole is completed.

19. Before proceeding with dissection:
   a. Study the muscle attachments for each muscle of the anterior thigh, anterior leg, and dorsum of the foot on the cadaver. Demonstrate the action of each muscle.
   b. Trace the course of the femoral nerve, obturator nerve, and superficial and deep peroneal nerves, looking at the point at which the muscular branch enters each muscle as well as any cutaneous supply.
   c. Follow the course of the femoral artery, anterior tibial artery, and dorsalis pedis artery, and review the branches listed in the objectives.
PROCEDURE: Position the cadaver prone. Place a block under the front of the ankle to relax the knee flexors.

NOTE TO THE DISSECTOR

The sural nerve is a cutaneous branch of the tibial nerve that supplies the skin of the posterior lateral aspect of the leg. The sural nerve is often joined by a communicating branch from the common peroneal nerve. In some cadavers, this communicating branch may descend separate from the sural branch of the tibial nerve. In this case, the lateral one from the common peroneal nerve is called the lateral sural nerve and the medial one from the tibial nerve is referred to as the medial sural nerve.

The small saphenous vein accompanies the sural nerve. This vein arises in the lateral foot and passes up the posterior leg. It will continue to the back of the knee where it will join the popliteal vein. The small saphenous vein and sural nerve will need to be preserved throughout dissection.

1. Review in an atlas the location of the sural nerve, the communicating branch from the common peroneal nerve, and the small saphenous vein.

2. Make a midline incision on the posterior leg to the level of the ankle. A horizontal incision should also be made across the posterior ankle from the lateral to the medial malleolus.

3. Remove skin from the posterior leg, and identify the sural nerve and small saphenous vein, which are superficial to the deep fascia (fascia cruris).

4. Excise the deep fascia using the incision lines shown in (Figure 22.1).

5. With the skin and fascia removed, return to the posterior thigh for further study.
   a. Locate the sciatic nerve in the lower posterior thigh and its division into the common peroneal and tibial nerves. Find the sural nerve.
   b. Identify the popliteal artery and vein. This vein is found superficial to the artery adhering to the posterior surface of the artery. Trace the small saphenous vein to where it enters the popliteal vein. Remove the popliteal vein, leaving a 1-inch piece
of this vein attached to fascia where the small saphenous vein enters it. The popliteal artery can now be seen clearly.

c. Trace the distal tendons of the following muscles to where they insert on the anterior-medial aspect of the proximal tibia:
   i. semitendinosus
   ii. gracilis
   iii. sartorius
   Note the relationship of these muscles to each other at the point of insertions.

d. Follow the semimembranosus to the posterior aspect of the medial condyle of the tibia. Note that the tendon of the semitendinosus passes superficial to the semimembranosus.

e. Find the insertion of the biceps femoris on the head of the fibula and the lateral condyle of the tibia.

6. Identify the medial and lateral heads of the gastrocnemius. Study the direction of muscle fibers for each head of this muscle. Locate the proximal attachments of this muscle. Demonstrate the actions of this muscle at both the knee joint and ankle joint.

7. With your fingers, trace a branch of the tibial nerve to each head of the gastrocnemius. Make a horizontal incision through the two heads of the gastrocnemius distal to the point where the nerves enter.

8. Reflect the two heads of the gastrocnemius distally to identify the soleus. Review the attachments of this muscle. Study the direction of the muscle fibers of the soleus and explain its action. Find a branch of the tibial nerve innervating this muscle on its superficial surface.

9. The plantaris can be seen at this time. Review the course and action for this small muscle.

10. Find where a branch of the tibial nerve enters the popliteus. Review the attachments of this muscle on the femur and tibia. Study the direction of its fibers in order to explain the rotational component of this muscle's action at the knee.

11. Place a probe deep to the tendo calcaneus, and cut through this large tendon (Figure 22.2). Release the attachment of the soleus along the soleal line (review in the atlas) of the tibia and the attachment along the medial shaft of the tibia, cutting very close to the bone. Perform these steps slowly, releasing only a few fibers at a time to ensure that the tibial nerve and posterior tibial artery are left intact. Turn the gastrocnemius, soleus, and tendo calcaneus laterally in order to view deeper structures.
12. Identify the flexor hallucis longus and flexor digitorum longus. Locate the proximal attachment of each of these muscles. Pull on their tendons and study the actions accomplished.

13. Pull aside the muscle bellies of the flexor hallucis longus and flexor digitorum longus, and identify the tibialis posterior, which is deep to these muscles, lying against the bone. Review the muscle attachments of the tibialis posterior. Pull on the tendon of this muscle and observe the actions achieved.

14. Trace the course of the tibial nerve in the posterior leg, locating the nerve branch to the flexor hallucis longus, flexor digitorum longus, and tibialis posterior. Study the point at which each nerve enters each muscle.

15. The popliteal artery can now be traced into the posterior leg. Before removing veins in the posterior leg:
   a. Identify genicular arteries.
   b. At the inferior border of the popliteus, the popliteal artery divides into the posterior tibial and anterior tibial arteries. The anterior tibial artery passes over the superior border of the interosseous membrane to enter the anterior compartment of the leg. The posterior tibial artery continues down the leg accompanying the tibial nerve. Locate this division of arteries.
   c. Find the peroneal artery. This artery branches from the posterior tibial artery at the upper border of the tibialis posterior and courses laterally. The flexor hallucis longus must be pulled laterally to view the distribution of the peroneal artery because it is deep to this muscle.

16. Deep veins in the posterior leg may now be removed so that arteries and nerves can be seen clearly. Preserve the great saphenous and small saphenous veins.

17. Review in an atlas the relationship of the structures found on the medial aspect of the ankle.

18. Cautiously remove skin from the medial side of the ankle.

19. Find the flexor retinaculum on the medial side of the ankle. Study the osseo-fibrous canals for the passage of the tendons of the tibialis posterior (Tom), flexor digitorum longus (Dick), and flexor hallucis longus (Harry), as well as the posterior tibial artery and vein, and the tibial nerve. Leave a small strip of the flexor retinaculum intact for later study.
PROCEDURE: Position the cadaver so the sole can be viewed easily. Elevate the foot on several blocks if needed.

1. Remove skin from the sole, the flexor surface of the great toe, and the first lateral toe. Discard skin.

2. Excise the thick heel pad of fat until the plantar aponeurosis is encountered.

NOTE TO THE DISSECTOR As dissection proceeds, branches of digital nerves and arteries can be seen in the distal metatarsal area deep to the plantar aponeurosis. These branches should be preserved.

3. Make an incision from the proximal to the distal end of the central portion of the plantar aponeurosis Figure 23.1. A horizontal incision should then be made through this central portion. Excise the distal slips of the plantar aponeurosis in the metatarsal area (Figure 23.1) by removing small pieces of tissue at a time.

4. Clean the medial and lateral portions of the plantar aponeurosis from the surface of the deeper muscles.

5. Identify muscles of the first layer:
   a. flexor digitorum brevis
   b. abductor digiti minimi
   c. abductor hallucis

   Review the attachments of each muscle and demonstrate their actions.

6. Identify digital plantar nerves and arteries.

7. Make a horizontal incision through the proximal end of the flexor digitorum brevis, and turn this muscle distally Figure 23.2.

8. Identify muscles of the second layer:
   a. quadratus plantae
   b. tendons of the flexor digitorum longus
   c. lumbricals

   Pull on the tendons of the flexor digitorum longus to observe this muscle's action. Locate the insertion of the quadratus plantae into the proximal portion of the tendon of the flexor digitorum longus. Read an account of the action of this muscle in relation to the angle of pull of the flexor digitorum longus.
9. Locate the tendon of insertion of the flexor hallucis longus, which can be seen at this level. Pull on this tendon to observe the action of this muscle.

**NOTE TO THE DISSECTOR** The tibial nerve divides into the medial and lateral plantar nerves on the medial aspect of the ankle. The medial and lateral plantar nerves then course into the foot to innervate intrinsic muscles of the sole. It is not necessary to find individual branches to each muscle in the sole from these nerves. The posterior tibial artery also divides in the same location. It branches into the medial and lateral plantar arteries, which supply the sole. Work to preserve the major portion of the medial and lateral plantar nerves and arteries.

10. Cut through the belly of the quadratus plantae and tendon of the flexor digitorum longus. 

11. Identify these muscles of the third layer:
   a. flexor digiti minimi brevis
   b. flexor hallucis brevis
   c. adductor hallucis—transverse and oblique heads

   Review the actions for each of these muscles.

12. Identify the dorsal and plantar interossei of the fourth layer. Review the actions of these small muscles.

13. Open the tendon sheath of the peroneus longus to view its tendon as it courses across the sole to insert on the base of the first metatarsal and the medial (first) cuneiform. Release tissue covering the tendon of the peroneus longus as it crosses the lateral foot and courses into the sole. This tendon should be viewed in its entirety as it courses around the lateral malleolus and heads into the sole of the foot.

14. Trace the medial and lateral plantar nerves posterior to the medial malleolus, where they divide from the tibial nerve. Remove a small portion of the proximal muscle fibers of the abductor hallucis as needed to follow these nerves into the sole.
15. Trace the course and insertion of each of the following muscles:
   a. tibialis posterior
   b. flexor hallucis longus
   c. flexor digitorum longus

   Note the relationships of these muscles as they:
   a. occur in the distal portion of the posterior leg
   b. pass posterior to the medial malleolus
   c. occur in the sole

16. Compare the insertions and actions of the tibialis anterior and the tibialis posterior.

17. Review the relationships and layers of the muscles and nerves in the sole of the foot.
Before proceeding with dissection of the joints of the lower limb:

1. Review the osteology of the lower limb.

2. Review muscle attachments and actions for each muscle of the posterior hip, posterior thigh, posterior leg, and sole.

3. Trace the course of each nerve dissected in the lower extremity. Note throughout the course of each nerve the level at which individual muscles are innervated. Locate the point at which each nerve enters each muscle.

4. Review the cord segments for each nerve. Identify cutaneous branches of these nerves, and indicate the area of cutaneous supply on the lower limb.

5. Review the arterial supply of the lower limb by tracing the arteries.

6. Review the venous system in the lower limb. Tributaries of the small saphenous vein drain into the popliteal vein. This vein then passes through the opening in the adductor magnus where it becomes the femoral vein. The femoral vein continues in the thigh until it passes deep to the inguinal ligament, where the name is changed to the external iliac vein. Trace the great saphenous vein, beginning on the dorsum of the foot. Follow this vein along the medial aspect of the leg and thigh until it joins the femoral vein. Cut open several inches of the great saphenous vein and study the valves.

7. Review the dermatome distribution of the lower limb.
The instructor will select the cadavers to be used for joint
dissection.

It will be necessary to refer to the lower extremity joints in the atlas during these
dissections.

HIP JOINT

PROCEDURE: Position the cadaver prone.

1. Remove the gluteus maximus, gluteus medius, gluteus minimus, piriformis, gemelli,
obturator internus, and quadratus femoris. Leave the obturator externus intact be-
cause it runs parallel to the ischiofemoral ligament and can be studied at the same
time.

2. Turn the cadaver to a side-lying position so the joint to be dissected can be moved
freely. Move the thigh into extension and into internal rotation, and observe that the
ischiofemoral ligament becomes taut during these motions. The obturator externus
may need to be excised if it hinders these movements.

3. Turn the cadaver supine. Remove the sartorius, tensor fasciae latae, rectus femoris,
and any remaining muscles that pass anterior to the hip joint. Flex the hip to put the
iliopsoas muscle on slack, then remove the iliopsoas as it passes anterior to the hip
joint.

4. Identify the iliofemoral ligament and pubofemoral ligament. Read a description of
the role of these ligaments at the hip joint.

5. Turn the cadaver to a side-lying position with the joint dissection superior. Move the
thigh into flexion–extension, abduction–adduction, internal, and external rotation,
and observe at what point the iliofemoral and pubofemoral ligaments become taut.


7. With the cadaver supine, continue to remove structures that are still obstructing
the view of the joint and ligaments. Open the anterior wall of the joint capsule by
making a vertical incision on the iliofemoral ligament and pubofemoral ligament.

8. In order to dislocate the head of the femur out of the hip joint, flex the knee and ro-
tate the thigh laterally. Push down on the knee toward the dissection table, forcing
the hip into extension and the head of the femur out of the acetabulum. Cut through
the ligamentum teres, leaving approximately 1/2 inch of this ligament attached to the
head of the femur. The head of the femur should come out of the acetabulum and
often makes a popping noise. Release more of the capsule if needed.

9. Identify:
   a. acetabular labrum
   b. ligamentum capitis femoris (ligamentum teres)
10. Study the movement of the head of the femur in the acetabulum throughout the range of each motion—i.e., flexion–extension, abduction–adduction, internal, and external rotation.

**KNEE JOINT AND SUPERIOR TIBIOFIBULAR JOINT**

**PROCEDURE:** Position the cadaver supine.

1. The central portion of the tendon of the quadriceps femoris passes from the patella to the tuberosity of the tibia as the ligamentum patellae. The medial and lateral portions of the tendon of the quadriceps femoris pass down on either side of the patella to insert into the tibia. They blend with the fibrous capsule to form the medial and lateral patella retinacula. Place a probe under the ligamentum patellae, then make a horizontal incision through this ligament. Continue the incision line for a short distance medially and laterally through the retinacula as needed to view the knee joint in its entirety.

2. Turn the patella proximally. Flex the knee and observe the articular cartilage on the surfaces of the medial and lateral femoral condyles.

3. Locate the medial meniscus and the lateral meniscus. Read an account of the differences in the shape of the menisci and the differences in the attachments of the medial and lateral menisci to the tibia.

4. Find the coronary ligaments along the edge of the menisci. These ligaments are small and often difficult to locate or are destroyed during the dissection. They attach the periphery of the menisci to the tibia.

5. With the knee flexed, identify the anterior cruciate ligament. Find the attachment of the posterior cruciate ligament on the medial femoral condyle. Read a description of the role of these ligaments in knee stability.

6. The insertions of the muscles of the pes anserinus area—i.e., sartorius, gracilis, and semitendinosus—will need to be excised on the
1. Define the limits of the joint capsule, and identify the medial (tibial) collateral ligament. See Figure 25.3.

7. The insertions of the iliotibial tract and biceps femoris are found on the lateral side of the knee. Define the limits of the joint capsule, and identify the lateral (fibular) collateral ligament.

8. Review in an atlas the extent of the synovial membrane throughout the knee joint. Reflect the patella proximally and identify synovial folds in the knee joint. Cut through the most superior aspect of this bursa to see muscle fibers of the articularis genu inserting into the joint capsule.

9. Indicate the areas where the prepatella and infrapatella bursa are located.

10. Turn the cadaver prone and release the origins of the heads of the gastrocnemius, the plantaris, and the popliteus. Vessels and nerves should also be removed to clearly view the posterior capsule of the knee.

11. In an atlas, review the location of the oblique popliteal ligament and arcuate popliteal ligament on the posterior aspect of the knee joint. The tendon of insertion of the semimembranosus sends slips to join the oblique popliteal ligament. The arcuate popliteal ligament arches over the origin of the popliteus as it emerges from the capsule. The dissector should study the location of these ligaments in the atlas prior to step 12, when they are removed with the capsule.

12. Remove posterior capsule as needed in order to identify the posterior cruciate ligament and the attachment of the anterior cruciate ligament on the lateral condyle of the femur as the knee joint is viewed from behind. See Figure 25.4.
13. Locate the posterior meniscofemoral ligament, a slip from the lateral meniscus, which passes to the medial condyle of the femur. This ligament is also known as the “ligament of Wrisberg.”

14. Locate the superior tibiofibular joint. Remove portions of the joint capsule to view the articulating surfaces. Move the fibula head to observe motion at this joint.

**ANKLE JOINT AND INFERIOR TIBIOFIBULAR JOINT**

**PROCEDURE:** Position the cadaver supine. Place a block under the ankle to elevate the foot.

1. Remove tendons crossing the front of the ankle joint.

2. Plantar flex the ankle joint, and make a horizontal incision across the anterior wall of the capsule of the joint. The approximation of the joint surfaces can be studied as the ankle is moved into dorsiflexion and plantar flexion.

3. On the lateral side of the ankle joint, identify the anterior and posterior talofibular ligaments and the calcaneofibular ligament. Read an account of the role of each of these ligaments in maintaining ankle stability.

4. On the medial aspect of the ankle, identify the deltoid ligament. Read a description of the role of this ligament in maintaining ankle stability.

**INTERTARSAL JOINTS**

**Subtalar Joint**

1. Identify the talus and calcaneus by palpation. Strip muscles and tendons from the posterior surface of the talus and calcaneus.

2. Locate the subtalar joint between the talus and the calcaneus. This joint allows for gliding in the movements of eversion and inversion.

3. Cut through the posterior wall of the capsule of the subtalar joint, and observe the surfaces of the talus and calcaneus during these movements.

**Talocalcaneonavicular Joint and Calcaneocuboid Joint**

1. Remove any remaining muscles and tendons, nerves, and vessels from the dorsum of the foot.

2. Identify the bifurcated ligament. This ligament forms a thickening over the dorsal surface of the calcaneocuboid joint. It is a band that attaches to the calcaneus proximally, then divides into two distal portions—one portion attaching to the cuboid and the other to the navicular.

3. Remove muscles, tendons, vessels, and nerves on the sole of the foot. Preserve the tendons of the peroneus longus, tibialis anterior, and
tibialis posterior as they cross the sole in their sheaths.

4. Identify the long plantar ligament. Read an account of the role this ligament plays in maintaining the arch of the foot.

5. Identify the short plantar ligament (plantar calcaneocuboid ligament). It may be necessary to cut across the long plantar ligament midway its length to observe the deeper short plantar ligament.

6. The spring ligament (plantar calcaneonavicular ligament) is located on the medial side of the foot, connecting the calcaneus to the navicular. This ligament gives support to the head of the talus. Locate the spring ligament. Read a description of the role of this ligament as well as the short plantar ligament in maintaining the arch of the foot.

7. Study the approximation of the joint surfaces of the navicular, the talus, the calcaneus, and the cuboid when the forefoot is moved in eversion and inversion.

8. Preserve the insertion of the peroneus longus, tibialis anterior, and tibialis posterior, which can now be seen clearly.

**Metatarsophalangeal Joints and Interphalangeal Joints**

1. Remove tendons on the dorsal surface of the metatarsophalangeal and interphalangeal joints of the great toe.

2. Identify the collateral ligaments for each of these joints.

3. Flex the great toe at the metatarsophalangeal joint. Make a horizontal incision across the dorsal surface of the capsule of the metatarsophalangeal joint to expose the head of the metatarsal. 

4. The interphalangeal joint of the great toe should also be opened by a horizontal incision across the dorsal surface of the joint capsule (Figure 25.7).

5. Look at the approximation of the articular surfaces as the metatarsophalangeal joint is moved in flexion, extension, abduction, and adduction.

6. Study the approximation of the articular surfaces of the interphalangeal joint as it is moved in flexion and extension.

**NOTE TO THE DISSECTOR** The collateral ligaments of the proximal and distal interphalangeal joints are found on the medial and lateral aspects of the respective joint on each toe. These collateral ligaments will not need to be dissected.
7. Open the proximal and distal interphalangeal joints of the first lateral toe by making a horizontal incision on the dorsal surface of the joint capsules.

8. Move these joints into flexion and extension, and note the approximation of the articular surfaces.
PROCEDURE: Position the cadaver supine. Place a block under the thorax to allow the neck to extend so the head hangs away from any support approximately 4–6 inches above the table. Place paper towels under the head to soak up fluids that may drain.

1. Remove the scalp from the cranium, using the incision lines shown in Figure 26.1.

2. With a bone saw, cut around the cranium, beginning on the frontal bone just superior to the orbit, moving posterior through the temporal fossa, and continuing to the external occipital protuberance Figure 26.2. As the saw is passing through, bone resistance will be felt. When there is a sudden “give,” withdraw the saw quickly so deeper brain tissue (the brain) will not be injured.

**NOTE TO THE DISSECTOR** It may be necessary to separate the cut edges of the skull using a chisel and hammer. This must be done carefully to avoid the chisel piercing the brain tissue.

3. Once the skull can be moved around slightly, release dura with a scalpel at the cut edges. Lift the skullcap from anterior to posterior, clipping any adhering pieces of dura.
In some cadavers, the skullcap may come off easily, leaving the dura still attached to the brain. In other cadavers, the dura may adhere tightly to the inner surface of the skull. In this case, the falx cerebri (the fold of dura in the mid-sagittal plane) will need to be clipped to remove the skullcap.

4. Work your fingers under the frontal lobe gently so brain tissue is not torn. The falx cerebri will need to be cut where it attaches to the crista galli.

5. Cut the optic nerves, leaving a small stalk of the nerves both in the optic canal as well as on the brain. Clip the infundibulum, releasing the hypophysis. The internal carotid arteries should be severed. Cranial nerves III and IV should be cut as they enter the skull, leaving a long stalk on the brain stem.

6. With your fingers, work into the middle cranial fossa on each side, lifting the temporal lobes out. Cranial nerve V should be severed at this time near the dura.

7. The tentorium cerebelli separates the cerebral hemispheres from the cerebellum. The cerebellum is located in the posterior cranial fossa. Make an incision through the tentorium cerebelli from anterior to posterior as well as horizontally so the cerebellum is free to be lifted out of the posterior cranial fossa. Cranial nerves VI, VII, and VIII should be clipped, leaving a long stalk on the brain stem.

8. With the scalpel, make a cut as low as possible on the brain stem to allow removal of the brain from the cranium. The brain will need to be stored in a separate bucket with preserving fluid as dictated by your facility. DO NOT store the brain in the cranium. Depending on your institution, the brain may be preserved for later dissection.
PROCEDURE: Position the cadaver supine. The orbit should be approached from inside the cranium; therefore, remove the skullcap and brain. Place a block under the head to raise it for easier viewing. This will stabilize the head as dissection proceeds.

1. Remove the dura mater from the orbital plate of the frontal bone.

2. Gently crack the orbital plate with a small hammer and chisel. Slowly remove the pieces of the orbital plate until the orbital cavity is clearly viewed. It will be necessary to remove fat in this area before identifying structures. This should be done with a probe very cautiously so small muscles and nerves are not destroyed.

3. Locate the levator palpebrae superioris and superior rectus. Study the actions of these two muscles.

4. Find the frontal nerve crossing the superior surface of the levator palpebrae superioris. The frontal nerve is a branch of the ophthalmic nerve from the fifth cranial nerve (CN V).
5. Cut the levator palpebrae superioris and superior rectus at their orbital attachments (the attachments to the eyeball located superiority and toward the frontal bone), and reflect these muscles back toward the cranium.

6. Identify the following muscles:
   a. superior oblique
   b. medial rectus
   c. lateral rectus

   Study the actions of these muscles.

   **NOTE TO THE DISSECTOR** The inferior oblique, inferior rectus, and lacrimal gland will be seen when the facial muscles are dissected.

7. Locate the optic nerve (CN II) and trace its path to where it was severed from the attachment to the brain.

8. The ciliary ganglion lies between the lateral rectus and the sheath of the optic nerve. It is a parasympathetic ganglion giving nerve supply to the sphincter of the pupil and the ciliary muscle of the eye. Dissection of this small ganglion is not necessary as long as the student can identify its general location.

9. The ophthalmic artery is a branch of the internal carotid artery, which enters the orbit by way of the optic canal. It is enclosed in the dural sheath with the optic nerve as it enters the orbit. The ophthalmic artery then branches, supplying the structures of the orbit. Numerous small branches can be seen in the orbit.

10. Two muscles of the orbit, inferior oblique and inferior rectus, can be studied with a dissection of the orbital cavity from the front. Make a small perpendicular incision in the lower eyelid to relax the tissue inferiorly. Make an incision through the conjunctiva (the white part of the eye) just inferior to the eyeball to locate the inferior oblique muscle and inferior rectus. Fat may be encountered in this area and will need to be removed.
This dissection should be done slowly over a couple of days to avoid becoming frustrated and removing structures of importance. Be patient as you discover these delicate structures. It is recommended that you use an atlas during this dissection.

**NOTE TO THE DISSECTOR**

The facial muscles are located in the superficial fascia of the skin; therefore, work cautiously when removing skin from the face. Cut away the skin in small pieces and discard. DO NOT attempt to keep the skin flap in one piece. The blade of your scalpel should be kept horizontal when working on the face. The face should be kept moistened and covered with a towel when dissection is completed, as it will dry rapidly if not given special attention.

1. Review in an atlas the locations of the facial nerve (CN VII) and its branches in relation to the parotid gland.

2. Remove the skin from the parotid area. **Figure 28.1**.
3. The parotid gland is encountered just deep to the skin in front of the ear. The facial nerve penetrates the deeper portion of the parotid gland and emerges just anterior to the external auditory meatus of the ear. Remove the earlobe at the level of the parotid gland. Continue to delicately remove the pieces of the parotid gland just anterior to the ear until nerve branches are encountered. Once a nerve branch has been located, follow the branch back to the major trunk of the facial nerve [Figure 28.2].

![Figure 28.2](image)

**Figure 28.2** Lateral view of the facial nerve and parotid area.

**NOTE TO THE DISSECTOR** Temporal branches of the facial nerve are more easily found than other branches (all branches of the facial nerve are wispy and delicate). As the skin in the parotid area is removed (step 2), several temporal branches may be found. Tracing these branches proximally will help the dissector locate the major trunk of the facial nerve.

4. Find each of the major branches of the facial nerve:
   a. temporal—These branches are found in the area between the ear and the lateral corner of the eye. They can be easily seen innervating the orbicularis oculi and the frontalis.
   b. zygomatic—These branches pass inferior to the orbicularis oculi and across the zygomatic bone near the origin of the zygomatic major.
   c. buccal—Its branches cross the upper portion of the masseter muscle to innervate the buccinator muscle of the cheek.
   d. mandibular—This branch crosses the lower portion of the masseter to enter the area of the depressor anguli oris (triangularis).
e. cervical—This branch crosses the facial vein between the inferior border of the mas-
seter and the submandibular gland.

Dissection should be done cautiously in this area to avoid destruction of these small struc-
tures. Continue to follow the course of the nerve branches onto the face by removing the
skin carefully in small pieces.

5. Once the facial nerve and its major branches have been located, remove skin from the
remainder of the face, preserving muscles, blood vessels, and nerves.

**NOTE TO THE DISSECTOR** The parotid duct emerges from the parotid gland, crosses the
surface of the masseter, then dives into the buccal area to enter the mouth. This duct may
or may not have been destroyed with the removal of the parotid gland. It is usually
slightly bigger than the nerves and is flat in appearance.

6. Locate the superficial temporal artery, which can be found just anterior to the ear. It
courses upward to supply the structures external to the cranium on the anterior lat-
eral side of the head.

7. Locate the facial artery as it passes superficial to the body of the mandible to enter the
face. This artery is found by placing the probe at a 45° angle from the corner of the
mouth to the mandible. This artery is a branch of the external carotid artery in the
neck. It has a tortuous course along the side of the mouth, going deep to the zygo-
matic major, levator anguli oris, and levator labii superioris. It emerges at the lateral
side of the nose as a much smaller vessel.

8. Find the facial vein, which accompanies the facial artery across the body of the
mandible. The facial vein lies just lateral to the facial artery and courses a path similar
to that of the facial artery. It originates in an anastomosis of veins around the orbit
and drains along the lateral side of the nose and cheek to cross the mandible with the
facial artery. It empties into the internal jugular vein via a venous network in the neck.

9. Identify these muscles of the forehead and orbit:
   a. frontalis
   b. corrugator supercilii
   c. orbicularis oculi

Demonstrate the action of each muscle. The occipitalis muscle can be located on the occipi-
tal bone and the mastoid portion of the temporal bone.

10. Locate the procerus and nasalis muscles of the nose. The dilator naris is located in the
alar cartilage of the nose. The depressor septi is found in the mobile portion of the
nasal septum just above the central incisor tooth. Demonstrate the actions of each of
these muscles.

11. Study the following muscles that are found in association with the upper lip:
   a. levator labii superioris
   b. zygomaticus major
   c. zygomaticus minor—This muscle takes origin from the zygomatic bone, crosses the
   belly of the caninus, and blends with the lateral fibers of the levator labii superioris.
   d. levator anguli oris (caninus)—This muscle is found deep to zygomaticus minor. Its in-
   duction blends with the orbicularis oris at the corner of the mouth.
   e. orbicularis oris
Demonstrate the actions of these muscles.

12. Identify the buccinator, the muscle of the cheek. The facial artery, vein, and buccal branches of the facial nerve are seen crossing the belly of this muscle. The risorius is another muscle of the cheek that lies superficial and is often removed when the skin is dissected. Demonstrate the actions of the buccinator and risorius.

13. Find these muscles associated with the lower lip and chin, and demonstrate their actions:
   a. depressor anguli oris (triangularis)
   b. depressor labii inferioris

Point to the location of the mentalis because this muscle is not readily visible.

14. The trigeminal nerve (CN V) is cutaneous innervation to the face. Small branches of this nerve emerge through foramina in the skull (supraorbital and infraorbital foramina, buccal foramen, and mental foramen), piercing facial muscles to enter the skin. Many of these cutaneous nerves are difficult to locate because they are very small and are found deep to facial muscles.

**NOTE TO THE DISSECTOR** The masseter is innervated by the mandibular branch of cranial nerve V and is considered a muscle of mastication (chewing) rather than a facial muscle. Facial muscles are innervated by cranial nerve VII—the facial nerve.
NOTE TO THE DISSECTOR: The joint(s) to be dissected will be selected by your instructor. Usually a few cadavers are selected so muscle attachments, nerves, and arteries are preserved on the majority of cadavers for later review. The instructor will select the cadavers for this dissection.

PROCEDURE: Position the cadaver supine with a block under the upper thorax. Use an atlas during this portion and refer to the DVD.

1. Identify the area of the temporomandibular joint on the cadaver. It is found just anterior to the external auditory meatus.

2. Remove the facial nerve and any remaining portions of the parotid gland from one side of the face. Be sure to leave the muscle bellies of the masseter and temporalis intact. The dissector should proceed slowly once the location of the temporomandibular joint has been established, so the capsule of this joint is not destroyed.

3. Identify the lateral fibers of the temporomandibular ligament (lateral ligament). This ligament is intimately related to the fibrous capsule.

4. Clean the masseter muscle so its attachment to the zygomatic arch can be clearly observed.

5. Run a probe deep to the zygomatic arch at the anterior margin of the temporalis muscle. Identify the most anterior location where the probe passes inferiorly. This is the anterior root of the zygomatic arch. Mark this place on the zygomatic arch.

6. Mark on the zygomatic arch the most posterior location the probe can be passed inferiorly. This indicates the posterior root of the zygomatic arch. It should be just anterior to the temporomandibular joint.

7. With a bone saw, cut through the two marked areas of the zygomatic arch as shown in Figure 29.1.

8. Reflect the masseter, turning it distally, and clip small masseteric nerves (CN V) and vessels as needed. Some of the anterior and posterior fibers of the masseter may need to be released at the zygomatic arch if their origin was not already cut.

9. Clean the temporalis muscle and study its attachment on the coronoid process.

10. Cut through the coronoid process with a bone saw as shown in Figure 29.2 so the insertion of the temporalis can be turned superiorly. Deep temporal nerves and vessels enter this muscle on its deep surface and may need to be released.

11. Draw a line on the ramus of the mandible beginning at the mandibular notch to midway down the mandible. Then continue the line anteriorly to the body of the mandible. With a bone saw, cut open this line so the anterior half of the ramus can be excised.

12. With the piece of bone removed, identify the lower and upper heads of the lateral pterygoid muscle, which lies just anterior to the condylar process. Read a description of the attachments and actions of this muscle.
Figure 29.1  Dissection lines of the zygomatic arch and mandible. A bone saw will need to be used for this cut.

Figure 29.2  Masseter reflected back. Cut line for the coronoid process of the mandible.

Figure 29.3  Cut line for removal of the ramus of the mandible.
13. Locate the medial pterygoid muscle, which is directly inferior to the lateral pterygoid. Study a description of the attachments and actions of this muscle.

14. Emerging between the lower border of the lateral pterygoid and the medial pterygoid are two nerves to be preserved—the lingual nerve (medial in relationship to the inferior alveolar nerve) and the inferior alveolar nerve (lateral in relationship to the lingual nerve). The lingual nerve is sensory to the mucous membranes of the tongue, floor of the mouth, and the mandibular gingivae. The inferior alveolar nerve is sensory to the teeth in the mandible and the skin of the chin and lower lip. It is also motor supply to the mylohyoid muscle.

15. The temporomandibular joint has a superior cavity and an inferior cavity separated by an articular disc. Only the superior cavity should be opened. Beginning at the most lateral point on the posterior root of the zygomatic arch, cut the capsule posteriorly, keeping the blade directed inferiorly along the posterior neck of the condylar process. An articular disc should be left covering the head of the condyle if the dissector is in the superior cavity. Cut the most anterior fibers of the capsule along the zygomatic arch, staying close to the periphery of the cavity. The disc can be seen covering the head of the condyle. Do not enter the inferior cavity.

16. The capsule should be cut medially, which will release the condyle for more movement. Rotate the condyle inferiorly to view the disc. Continue to release capsular fibers attached to the zygomatic arch as needed to see the disc.

17. Place a probe in the superior cavity, and gently pull on the disc in an anterior–posterior direction and a medial–lateral direction, studying the degree of movement in each. Note the lateral, anterior, and posterior freedom of movement the disc has relative to the condyle.

18. With a bone saw, cut through the remainder of the ramus of the mandible so the posterior aspect of the ramus may be excised.

19. With the ramus removed from the cadaver, make an anterior–posterior incision in the middle of the disc and examine the thickness of the cut surface. Cut the disc medial to lateral across the superior region. Note the thickness of the disc. Define the posterior band and the anterior band of the disc.

20. Study the shape of the articular surfaces of the mandibular fossa and articular tubercle of the temporal bone. Note the shape of the articular disc as it conforms to these articular surfaces.
**PROCEDURE:** Position the cadaver supine. Place a block under the thorax so the neck is extended.

1. Review in an atlas the location of the following structures before proceeding with dissection:
   a. external jugular vein
   b. sternocleidomastoid muscle
   c. supraclavicular nerves
   d. spinal accessory nerve

2. Make an incision from the mastoid process of the temporal bone to the sternal end of the clavicle. A second incision should be made along the length of the clavicle. Remove the skin from the lateral neck with care.

**NOTE TO THE DISSECTOR** Many of the cadavers have been embalmed at the neck, and a large skin incision may already be present. If this is the case, clean out the jelled embalming fluid and blood in the area, trimming back cut edges of torn vessels and muscles. Cut ends of nerves and vessels may be joined with string or rope. **DO NOT** remove the string if present. All attempts should be made to preserve as many structures as possible in the area. Numerous lymph nodes may also be encountered in the lateral and anterior neck. These should be removed. Work cautiously around the embalming site to prevent further damage of the tissue in the area.

3. The platysma muscle is embedded in the superficial fascia of the neck; therefore, it is removed inadvertently as the skin is taken off. A few strands of this muscle may be seen inserting on the inferior border of the mandible.

4. The external jugular vein ascends along the superficial surface of the sternocleidomastoid. This vein may be removed as the skin is removed.

5. Locate the posterior cervical triangle formed by the sternocleidomastoid, trapezius, and middle third of the clavicle.

6. Identify the investing layer of deep fascia of the posterior triangle. This is called “prevertebral fascia” and is found overlying the levator scapulae and trunks of the brachial plexus.

7. The spinal accessory nerve (CN XI) emerges at the posterior border of the sternocleidomastoid at the midpoint of its length, then passes posteriorly, descending across the
deep fascial layer of the posterior triangle to enter the anterior border of the trapezius near the clavicle. Remove fat and lymph nodes cautiously in this area until the spinal accessory nerve has been located.

8. Supraclavicular nerves emerge from the posterior edge of the sternocleidomastoid superficial to the deep fascia. They descend directly beneath a venous network at the clavicle, then cross superficial to the clavicle to innervate the skin in this area. Be sure not to confuse these cutaneous nerves with the accessory nerve in step 7.

9. Crossing superficial to the deep fascial layer is the transverse cervical artery (transverse colli artery). It is a branch from the thyrocervical trunk off the subclavian artery and passes posteriorly near the clavicle to enter the trapezius and accompany the spinal accessory nerve.

10. Look at the attachments of the sternocleidomastoid and demonstrate the actions of this muscle. The accessory nerve (spinal portion) innervates the sternocleidomastoid after it crosses the internal jugular vein deep to this muscle. It enters the sternocleidomastoid at approximately the level of the hyoid bone.

11. Release the sternocleidomastoid at its sternal attachment. Locate a branch of the spinal accessory nerve to this muscle.

12. Review in an atlas the location of the scalene muscles and the levator scapulae deep to the fascial layer.

13. Study in an atlas the location of the following structures before proceeding with dissection:
   a. brachial plexus—emerges between the anterior scalene and the middle scalene muscles
   b. long thoracic nerve—exits posterior to the middle scalene to enter the upper fibers of the serratus anterior
   c. dorsal scapular nerve—pierces through the middle scalene, then dives deep to the levator scapulae
   d. small cervical nerve branches to the levator scapulae—seen entering this muscle superficial to the dorsal scapular nerve
   e. suprascapular artery—a branch off of the thyrocervical trunk, which is a branch from the subclavian artery. It crosses superficial to the scalene anterior and the brachial plexus. Near the coracoid process, it enters the scapular region where it was previously dissected in the supraspinous fossa.
   f. suprascapular nerve—exits the brachial plexus at the proximal border of serratus anterior and the distal posterior border of the middle scalene
   g. phrenic nerve—found on the anterior surface of the anterior scalene

14. Cut the clavicle with a bone saw at the medial and lateral extremities of its exposure to better view the structures beneath.

15. With the clavicle removed and the sternocleidomastoid reflected, remove the deep layer of fascia, keeping well in mind the structures in step 13 that are found just deep to the fascia or within it.

16. Identify the following muscles:
   a. levator scapulae
   b. anterior scalene
   c. middle scalene
d. posterior scalene—This muscle is found deep to levator scapulae and the middle scalene.

Review muscle attachments and actions for these muscles.

17. Find the brachial plexus emerging between the anterior scalene and the middle scalene. The trunks of the brachial plexus can now be seen clearly.

18. Identify the following nerves:
   a. long thoracic
   b. dorsal scapular
   c. suprascapular
   d. phrenic

**NOTE TO THE DISSECTOR** If these nerves are not readily seen, it would be more efficient to proceed with steps 19–20. **DO NOT** risk destruction of the nerves by arduous efforts at dissection.
19. Beginning at the serratus anterior, trace the long thoracic nerve proximally to where it exits just posterior to the middle scalene.

20. Tilt the cadaver slightly onto its side so the scapula can be viewed.
   a. Find the dorsal scapular nerve, which innervates the rhomboid major and minor. Trace this nerve proximally to where it pierces the levator scapulæ. Continue tracing its course through the levator scapulæ to the middle scalene.
   b. Locate the suprascapular nerve as it enters the supraspinous fossa. Trace this nerve proximally to the upper trunk of the brachial plexus.

**NOTE TO THE DISSECTOR** It is imperative that the dissector perform steps 19–20 to confirm the identity of these nerves.

21. Reposition the cadaver supine.

22. Find the nerves to the levator scapulæ.

23. Locate the phrenic nerve and determine its relationship to the anterior scalene. Preserve this nerve for later review when the diaphragm is studied.

24. Identify the following arteries:
   a. subclavian artery—as it emerges between the anterior scalene and the middle scalene
   b. suprascapular artery—found superficial to the anterior scalene. It passes deep to and parallel with the clavicle, then courses toward the superior border of the scapula.
1. Remove skin from the anterior neck by making a midline incision from the hyoid bone to the jugular notch. The skin will not be saved. A horizontal incision should be made along the length of the hyoid bone. Continue to remove the platysma muscle covering the anterior neck.

2. Remove skin from the suprahyoid region by making a midline incision from the mandible to the hyoid bone (Figure 31.1).

3. With the skin removed, identify the following:
   a. hyoid bone
   b. thyroid cartilage
   c. cricoid cartilage
   d. thyroid gland
   e. trachea

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**Figure 31.1** Skin incision lines on the anterior neck.
4. The small muscles of the anterior neck are often referred to as the “strap” muscles or infrahyoid muscles. These include the sternohyoid, sternothyroid, omohyoid, and thyrohyoid. Find the sternohyoid muscle and the anterior belly of the omohyoid muscle. Review the actions of these muscles. See Figure 31.2.

5. Release the sternal attachment of the sternohyoid to view deeper structures.

6. Identify the sternothyroid and thyrohyoid muscles (Figure 31.2). Study the actions of these muscles.

7. Study the cervical plexus in an atlas. Locate the carotid sheath on the cadaver. On the superficial surface of the carotid sheath, the superior root of the ansa cervicalis and the inferior root from cervical spinal nerves 2 and 3 (C2 and C3) join to form the ansa cervicalis approximately 2 inches inferior to the submandibular gland. The ansa cervicalis has contributing branches from cervical spinal nerves 2 to 5 (C2 to C5).

**NOTE TO THE DISSECTOR** The ansa cervicalis is very difficult to find, as it is easily destroyed when dissecting in the anterior neck. If the ansa cervicalis cannot be found readily, the dissector should proceed with a study of the contents of the carotid sheath.
8. Cut open the carotid sheath cautiously to view the internal jugular vein, common carotid artery, and vagus nerve (CN X).

9. Trace the common carotid artery to the level of the superior border of the thyroid cartilage. Note the division of the common carotid into external and internal carotid arteries at this level. The internal carotid artery is posterior to the external carotid artery.

10. The internal jugular vein is frequently used for embalming cadavers; therefore, portions of this vein may be missing or destroyed. Clean the cut edges and clear away any remaining jelled embalming fluid and blood. The cut ends may be joined with string.

**NOTE TO THE DISSECTOR** The vagus nerve (CN X) is found in the carotid sheath between the internal jugular vein and the common carotid artery. This nerve and its branches, the right and left recurrent laryngeal nerves, will be traced in more detail when the thorax is dissected.

11. Locate once again the thyroid gland. Note that it is seen anteriorly at the upper end of the trachea. The lobes extend upward and laterally, deep to the sternothyroid muscle to the lower border of the thyroid cartilage.

12. In the suprahoid area, the “suprahoid” muscles consist of the mylohyoid, digastric, stylohyoid, and geniohyoid. Only the mylohyoid (just superior to the anterior belly of the digastric) and the anterior belly of the digastric need to be dissected (Figure 31.2). Remove the submandibular gland carefully to identify the mylohyoid muscle and the anterior belly of the digastric. An intermediate tendon attached to the hyoid bone connects the anterior belly of the digastric to the posterior belly of this muscle (not dissected).

13. Find the hypoglossal nerve (CN XII). It passes deep to the intermediate tendon of the digastric and can be located between the intermediate tendon and the posterior border of the digastric. Often seen in this area is the stylohyoid, running from the styloid process proximally to the hyoid bone.

14. Read an account of the role of the suprahoid and infrahoid muscles in the act of deglutition.

15. Review the cutaneous innervation and dermatome distribution for the head and neck.
Anterior neck structures.

- Hyoid bone
- Thyroid cartilage
- Sternohyoid
- Omohyoid
- Internal jugular vein
- Carotid artery and its divisions
- Anterior belly of digastric
- Intermediate tendon to posterior belly of digastric
- Submandibular gland
The Larynx

Dissection of the larynx will be done only on select cadavers; however, every student should review this section on the cadaver. The purpose of this dissection is to study the relationship of the pharynx, esophagus, and epiglottis to the glottis, vocal folds, and trachea. A detailed study of the intrinsic muscles and the nerves of the larynx is not within the scope of this dissection.

1. Make an incision through the trachea, esophagus, and associated structures just inferior to the cricoid cartilage. Make a second incision just superior to the hyoid bone. Be careful not to injure the carotid arteries, internal jugular vein, and vagus nerve. Continue the incision through the posterior wall of the pharynx. Release the larynx and esophagus from the surface of the vertebrae, and remove the entire structure from the cadaver.
2. On the anterior surface of the larynx, identify the thyroid cartilage and the cricoid cartilage.

3. On the posterior surface of the pharynx, locate the inferior pharyngeal constrictor and the esophagus.

4. Read a description of the actions of the constrictor muscles during deglutition.

5. Cut open the inferior pharyngeal constrictor and the esophagus by making a midline incision through the posterior surface of these muscles.

6. With the constrictors held aside, locate the epiglottis.

7. Make a midline incision on the posterior surface of the larynx through the trachea and the cricoid cartilage so the larynx can be held open in order to study the interior structures.

8. Identify the vocal folds within the larynx. The glottis is the opening between the vocal folds.

9. With the larynx removed from the cadaver, find the lower fibers of longus colli and capitis muscles as they attach to the anterior tubercles of the transverse processes of cervical vertebrae. Study the actions of these muscles in relation to head and neck movements.

10. Locate the anterior longitudinal ligament on the anterior surface of the vertebrae.
The purpose of the following study is to familiarize the dissector with the autonomic nervous system. This system consists of both sympathetic and parasympathetic portions, which constitute **efferent supply** to thoracic, abdominal, and pelvic viscera, as well as to vessels and glands.

The **sympathetic system** consists of ganglia found in the neck and the sympathetic chain of ganglia running along the lateral and anterior bodies of the vertebrae, receiving preganglionic fibers from the spinal cord (thoracic spinal nerves 1–12 to the first lumbar spinal nerve). These nerves continue into the abdomen and pelvis to form multiple networks or plexuses.

The **parasympathetic system** is often referred to as the “craniosacral” outflow. The cranial portion takes origin from cranial nerve nuclei, and its fibers course as a part of the cranial nerve distribution (a large contributor in the thorax and abdomen is CN X). The sacral portion (S2–4) exits the spinal cord as a part of the sacral spinal nerves. Parasympathetic preganglionic fibers join multiple ganglia and plexuses throughout the neck, thorax, abdomen, and pelvis and are found around major arteries in these areas.

The following ganglia or plexuses will be described briefly in this guide as each region is dissected:

**Neck**
- superior cervical ganglia
- middle cervical ganglia
- cervicothoracic (stellate) ganglia

**Thorax**
- pulmonary plexus
- cardiac plexus
- coronary plexuses
- sympathetic trunk
- aortic plexus

**Abdomen**
- celiac plexus
- aortic plexus
- superior mesenteric plexus
- inferior mesenteric plexus
- suprarenal and renal plexuses

**Pelvis**
- superior hypogastric plexus
- inferior hypogastric plexus

Preservation of these plexuses during dissection is not essential. But the dissector should take time to identify their location as cleaning is carried out in their respective areas.
AUTONOMIC CONTROL IN THE CERVICAL REGION

The cervical part of the sympathetic nervous system consists of three ganglia:

1. superior cervical
2. middle cervical
3. cervicothoracic or stellate ganglia

These ganglia are located in the neck and are interconnected by intervening nerves.

1. The **superior cervical ganglion** is at the level of the second and third cervical vertebrae, with the longus capitis muscle posterior and the internal carotid artery anterior. Fibers from this ganglion pass along the internal carotid artery to enter the cranial cavity. Branches are sent to the lacrimal gland; mucosa of the nose and mouth; submandibular, sublingual, and parotid glands; as well as the ciliary and sphincter pupillæ muscles of the eye. The parasympathetic system, by way of cranial nerves III, VII, and IX, also innervate these structures. In addition, the superior cervical ganglion sends branches joining the vagus, glossopharyngeal, and hypoglossal nerves to the pharyngeal plexus and the cardiac plexus.

2. The **middle cervical ganglion** supplies the thyroid and parathyroid glands, trachea, and esophagus, and it joins the cardiac plexus. This ganglion is found at the level of the sixth cervical vertebra, lateral to the thyroid gland at the lateral border of longus colli.

3. The **cervicothoracic (stellate) ganglion** also lies lateral to the lateral border of longus colli, between the base of the transverse process of the seventh cervical vertebra and the neck of the first rib. This ganglion has fibers, which join the cardiac plexus and the vertebral artery plexus. Its fibers supply blood vessels in the upper limb.

It is not necessary to dissect these ganglia in the neck. Read a more thorough description of these ganglia and their interconnecting fibers in a textbook. Knowing the relationship to structures in the area of their distribution will assist in the understanding of their function.
PROCEDURE: Position the cadaver supine.

1. Identify external and internal intercostal muscles on the anterior wall of the thorax. Review the attachments and actions of these muscles.

2. With a bone saw, cut through the anterior-lateral surface of the ribs as shown in Figure 34.1a. Be sure to withdraw the saw quickly once a “give” is felt to prevent injuring the underlying lung tissue. Remove the sternal end of the clavicle and proximal sternum. Follow the incision line with a scalpel along the edge of the ribs and xiphoid process (Figure 34.1b). Cautiously release tissue deep to the ribs and sternum in order to remove the anterior thoracic wall completely from the cadaver.

3. With the anterior thoracic wall removed from the cadaver, identify on the posterior surface of this wall the internal intercostal muscles. Note the difference in the direction of fibers of these muscles in contrast to the external intercostals. Review the actions for these muscles:
   a. transversus thoracic muscles—Study the role of these muscles in depressing the sternum and ribs.
   b. intercostal nerves—They are located along the inferior border of each rib. Look in the tissue just distal to the cut edge of each rib. An intercostal nerve and artery are usually found together piercing the muscle tissue.
   c. internal thoracic (internal mammary) artery—This artery is a branch from the subclavian artery and courses along the lateral side of the sternum, coursing inferiorly. It will anastomose with arteries in the epigastric region.

4. Review the location and actions of the levator costorum muscles. These muscles were previously dissected when the back muscles were dissected.

**NOTE TO THE DISSECTOR** The pulmonary pleura, a serous membrane, covers the surface of the lung and extends into the fissures between the lobes. The remainder of this membrane, the parietal pleura, lines the inner surface of the thorax, the diaphragm, and structures in the middle of the thorax. The pleural cavity is a potential space between the two layers of pleura. The interval between the two pleural sacs (right and left) is called the interpleural space or mediastinum. The term mediastinal pleura is in reference to that
The thorax—the lungs

Pleurae forming the lateral boundary of the mediastinum. The mediastinum is divided into two parts, superior and inferior mediastina. The inferior mediastinum is further subdivided into anterior, middle, and posterior mediastina. Read a description of the extent of each mediastinal space and the structures found in each portion.

5. Open the pleurae. Leave the heart enclosed in pericardium at this time. Before disturbing any structures in the thorax, take time to study the position of the heart in relation to the lobes of each lung and the diaphragm. The upper and lower lobes of the left lung, oblique fissure, and lingula of the upper lobe can be viewed. The upper, middle, and lower lobes of the right lung are clearly seen as well as the anterior portion of the transverse and oblique fissures. Note the position of the heart over the central tendon of the diaphragm, with the apex of the heart pointing to the left. A piece of parietal pleura is discernible, extending proximally between the right and left lungs.

Autonomic Nervous System—Pulmonary Plexus

The pulmonary plexus is located on the bronchial and vascular structures found in the roots of the lungs. It is formed by branches from the vagus nerve (parasympathetic) and branches from the sympathetic system. **Function:** These branches regulate bronchoconstriction and bronchodilation, vasoconstriction and vasodilation, and secretions of the mucous bronchial glands. The dissector should study the location of this plexus in an atlas; however, dissection of this plexus is not necessary.

6. With your fingers, find the root of each lung where the bronchus and great vessels enter the lungs.

7. Release the great vessels and bronchus on each side close to the lung tissue using a scalpel **Figure 34.2**.

**Figure 34.2**

Heart and lungs—anterior view. Incision lines through the root of the lungs and bronchus.
8. Take each lung out of the thorax and identify the structures of the root of the lungs. This is accomplished by working the tissue and pleura loose from the thoracic wall with your fingers. It may be necessary to cut some lung tissue if it is adhered to the thoracic wall.
   a. bronchus
   b. right and left pulmonary arteries
   c. right and left pulmonary veins

9. On the right lung, identify the horizontal fissure and the oblique fissure. Identify the upper, middle, and lower lobes. On the left lung, locate the oblique fissure. Identify the upper, lower, and lingular lobes.

10. On the surface of each lung, determine the approximate location of the following bronchopulmonary segments listed in Table 34.1.

### Table 34.1 Bronchopulmonary segments.

<table>
<thead>
<tr>
<th>RIGHT LUNG</th>
<th>Lobe</th>
<th>Segment</th>
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<tbody>
<tr>
<td>Bronchus</td>
<td>Upper</td>
<td>Apical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posterior</td>
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<td>Anterior</td>
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11. Locate the phrenic nerve again on the anterior surface of the anterior scalene muscle. With the lungs removed, trace this nerve along the lateral surface of the pericardium with a probe to the diaphragm. It is found deep to the mediastinal pleura, covering the pericardium.

12. Study the attachments of the sternal and costal portions of the diaphragm on the cadaver. Read a description of the role of the diaphragm in respiration.

**NOTE TO THE DISSECTOR** The attachment of the lumbar portion of the diaphragm will be seen when the abdomen is dissected.
1. Look for remnants of the thymus gland. This gland is an organ of the lymphoid system. It varies in size with age. Remnants of this gland are found at the proximal limit of the pericardial sac covering the ascending aorta, superior vena cava, and pulmonary trunk. It may extend superiorly as far as the thyroid gland.

2. Open the pericardium using a probe; a scalpel may be used if necessary. Be careful not to puncture the heart. Before displaying the heart, identify the following structures:
   a. right atrium
   b. right ventricle
   c. superior vena cava
   d. ascending aorta
   e. left ventricle
   f. apex of the heart
   g. pulmonary trunk

   **NOTE TO THE DISSECTOR** The inferior surface of the heart is often referred to as the diaphragmatic surface. It is formed by the two ventricles, right and left.

3. Review in an atlas the location of the ligamentum arteriosum and the course of the right and left vagus nerves into the thorax. Review the location of the recurrent branch of the vagus nerve on the left, which loops under the aortic arch.

4. Carefully remove pericardium and pleura from the great vessels, being well aware of the structures in step 3.

5. Find the arch of the aorta. The brachiocephalic trunk arises from the aortic arch, then divides into a right common carotid artery and a right subclavian artery. The left common carotid artery and left subclavian artery branch directly from the arch of the aorta. Locate these arteries.

6. The pulmonary trunk ascends from the right ventricle just inferior to the aortic arch. This trunk divides into a right and left pulmonary artery, which carries blood to the lungs. Find the ligamentum arteriosum, which is located between the left pulmonary artery and the inferior surface of the aortic arch. In the fetal state, the ligamentum arteriosum is a ductus arteriosus. This duct shunts blood from the pulmonary trunk into the aorta, where it descends with the oxygenated blood. There is constriction of this duct at birth and a slow replacement with ligamentous tissue during development.

7. Venous blood from the internal jugular veins and the subclavian veins drains into the right and left brachiocephalic veins. These, in turn, empty into the superior vena cava. Identify these veins. Venous blood from the lower portion of the body drains into the inferior vena cava, which will empty into the right atrium immediately after passing through the vena cava foramen of the diaphragm.

8. Continue to remove pleura along the right side of the superior vena cava and progressing deeper to the vertebrae. Locate on the posterior aspect of the superior vena cava the arch of the azygos vein. The azygos vein arises from the posterior surface of the in-
The Thorax—The Heart

Inferior vena cava just below the diaphragm. It passes into the thorax and ascends along the front of the thoracic vertebrae, then arches upward to enter the superior vena cava.

NOTE TO THE DISSECTOR: Review in an atlas the course of the thoracic duct in relation to the trachea, esophagus, and great vessels in the area of the first rib and root of the neck. As structures are cleaned and identified in this area, preserve the thoracic duct. It drains into the venous system at the junction of the left subclavian and left internal jugular vein. See step 25.

9. Identify the right vagus nerve in the anterior neck. As this nerve passes superficial to the subclavian artery, it gives off a right recurrent branch. The right recurrent laryngeal nerve then loops under the subclavian artery and passes medially to ascend along the trachea.

10. Locate the left vagus nerve in the anterior neck. As this nerve passes over the left side of the aortic arch, it gives off a left recurrent branch, which loops under the aortic arch and then passes medially to ascend along the trachea.

11. Note the position of the trachea and bronchi in relation to the great vessels.
AUTONOMIC NERVOUS SYSTEM—CARDIAC PLEXUS

The cardiac plexus consists of several small ganglia. It lies anterior to the bifurcation of the trachea, posterior to the arch of the aorta, and superior to the bifurcation of the pulmonary trunk. It receives nerves from the cervical and upper thoracic ganglia of the sympathetic trunk and the cardiac branches of the vagus and recurrent laryngeal nerve (parasympathetic).

Function: These filaments regulate the acceleration and slowing of the heart. It is not necessary to dissect this plexus.

12. Free the heart by making horizontal incisions, cutting through the ascending aorta, right and left pulmonary arteries, right and left pulmonary veins, superior vena cava, inferior vena cava, and the arch of the azygos vein. Leave a stump for each vessel (Figure 35.1).

13. Remove the heart from the cadaver and review the structures on the anterior surface that were seen in step 2.

14. Identify on the posterior aspect of the heart:
   a. left ventricle
   b. left atrium
   c. right and left pulmonary veins
   d. right and left pulmonary arteries
   e. inferior vena cava

15. Cut open the right atrium as shown in Figure 35.2. Identify:
a. opening of the superior vena cava
b. opening of the inferior vena cava
c. fossa ovalis
d. pectinate muscles
e. crista terminalis
f. valve of the coronary sinus
g. right atrioventricular orifice (tricuspid valve)
h. location of the sinoatrial node—it is located at the upper end of the crista terminalis in front of the opening of the superior vena cava.
i. location of the atrioventricular node—This node is embedded within the myocardial fibers of the interatrial septum just superior to the opening of the coronary sinus.

**NOTE TO THE DISSECTOR** The heart will be full of dried blood. The heart will need to be cleaned and rinsed at the tissue sink. Do this slowly to avoid destroying the inner structures.

In **fetal circulation**, blood from the inferior vena cava (oxygenated from the placenta) enters the right atrium, then passes through the foramen ovale into the left atrium (Figure 35.3). At birth, the intra-atrial pressures are equalized, and the septa overlapping the foramen stays in contact and, shortly thereafter, fuses. The floor of the fossa ovale is formed from these original septa.
16. Cut open the right ventricle as shown in Figure 35.4. Identify:

a. cusps of the right atrioventricular (tricuspid) valve
b. papillary muscles—These muscles are attached by their bases to the wall of the ventricle, while their apices project into the cavity and are attached to the chordae tendineae of the tricuspid valve.
c. chordae tendineae—These delicate tendinous cords connect the papillary muscles to the cusps of the tricuspid valve.
d. trabeculae carneae—These are round or irregular muscle columns in the ventricular wall.
e. interventricular septum—This is the wall between the ventricles.
f. conus arteriosus (infundibulum)—This area has smooth walls, which lead upward to the pulmonary orifice.
g. cusps of the pulmonary valve
h. pulmonary trunk

Figure 35.4 Incision lines on the right ventricle—anteroventricular.
17. Make an incision through the wall of the left atrium and left ventricle on the poste-
rior surface of the heart. Figure 35.5.

18. Identify the left atrioventricular (mitral or bicuspid) valve, and observe the two cusps
of this valve.

19. Clip open the ascending aorta (Figure 35.4) on its anterior surface. Identify the aortic
(semilunar) valve. Find the orifices of the coronary arteries.

20. With your fingers, hold open the left ventricle and observe the cusps of the aortic valve.

21. Place the point of a probe into the right coronary artery inside the aorta to mark it.
With another probe, clear fat surrounding the right coronary artery from the epi-
cardium. Follow the right coronary artery into the sulcus between the right atrium and
right ventricle. Locate the marginal branch of the right coronary artery. Follow the
right coronary artery to the posterior surface of the heart to locate the posterior in-
terventricular artery.

Figure 35.5 Incision lines on the left ventricle and left atrium—posterior view.
22. Place the point of a probe into the left coronary artery inside the aorta to mark it. Remove fat surrounding this artery, and follow its course between the aorta and pulmonary trunk to where it divides into an anterior interventricular branch and a circumflex branch. The circumflex branch follows a groove between the left atrium and left ventricle. Clean both of these arteries so they can be studied.

AUTONOMIC NERVOUS SYSTEM—CORONARY PLEXUSES

Coronary arteries receive innervation from autonomic nervous system plexuses. Coronary plexuses accompany the coronary arteries. **Function:** These plexuses are concerned with dilation and constriction of coronary arteries. Dissection of these plexuses needs not be done.

23. The great cardiac vein of the heart receives tributaries from veins arranged in a similar manner to the arterial tree. The great cardiac vein passes in the groove between the left atrium and left ventricle to enter the coronary sinus located posterior to the right atrium. The coronary sinus empties into the right atrium through a small opening with a valve located just below the fossa ovale. Find the great cardiac vein, coronary sinus, and opening of the coronary sinus in the right atrium.

24. With both the heart and lungs removed from the cadaver, continue to remove pericardium and pleura cautiously (so as not to destroy structures lying within and below) as needed to identify:
   a. esophagus
   b. bronchi
   c. thoracic (descending) aorta
   d. azygos vein
   e. hemizygous vein—This vein is found on the left side of the lower thoracic vertebral column up to the eighth thoracic vertebra, where it crosses to join the azygos vein. Sometimes an accessory hemizygous vein will descend on the left from the fourth to the eighth intercostal spaces. Not every cadaver will have this vein.

25. The lymphatic system of the thorax drains into the thoracic duct, which extends from the lower border of the twelfth thoracic vertebra and enters the thorax through the aortic opening of the diaphragm. The thoracic duct is a delicate structure and is easily torn, so use your probe, making parallel strokes along the thoracic vertebrae to find its location. The thoracic duct is found on the anterior surface of the thoracic vertebral column and ascends with the aorta on its left and the azygos vein on its right. Opposite the fifth thoracic vertebra, the thoracic duct inclines to the left and ascends posteriorly then along the side of the esophagus. It is crossed anteriorly by the aortic arch and lies behind the left subclavian artery. As it enters the neck, it arches laterally, passing in front of the phrenic nerve and medial border of scalene anterior. It ends at the junction of the left subclavian and left internal jugular vein. Identify the thoracic duct.

26. The anterior surface of vertebrae, intercostal muscles, and nerves are covered in costal pleura. Along the sides of the vertebrae, near the heads of the ribs, are a series of chain ganglia covered in costal pleura coursing the length of the thoracic cage. These are the sympathetic chain ganglia. Remove much of the pleura in the thoracic cage, using parallel strokes with your probe along the sides of the vertebrae so that the intercostal muscles, nerves, and sympathetic chain ganglia can be seen. Locate the greater splanchnic nerve, originating from the sympathetic chain ganglia T5–T9 and passing caudally to end in the celiac ganglion of the abdomen. The splanchnic nerves angle toward the anterior bodies of the vertebrae.
Note the anterior longitudinal ligament on the anterior surface of the bodies of the vertebrae. This ligament was also studied on the cervical vertebrae.

**AUTONOMIC NERVOUS SYSTEM—SYMPATHETIC TRUNK, AORTIC PLEXUS, SPLANCHNIC NERVES**

The thoracic portion of the sympathetic system arises from this series of ganglia. Two rami communicants, white and grey, connect each ganglion with its spinal nerve. The white ramus contains the preganglionic fibers from the intermediolateral cell column of the spinal cord. These fibers course to the sympathetic ganglia. The grey ramus contains postganglionic fibers from the sympathetic chain, which are joining the spinal nerve to go to the periphery. Some of these fibers will ascend or descend in the chain. These communicants may be seen in the laminectomy dissection.

The thoracic aortic plexus arises from the upper five chain ganglia. They supply filaments to the thoracic aorta and its branches. Twigs from these levels also enter the pulmonary plexus and cardiac plexus. These plexuses resemble a tangled network of small nerves, and it is not necessary that they be dissected. Parasympathetic supply in the thorax is by way of cranial nerve X, the vagus nerve. **Function:** Branches from this nerve go to plexuses of the heart, trachea, bronchi, and esophagus.

The greater and lesser splanchnic nerves are found coursing on the anterior surfaces of the bodies of vertebrae, before piercing the diaphragm. The greater splanchnic nerve originates from chain ganglia T5–T9. This nerve is a preganglionic visceral efferent fiber. It supplies the descending aorta then ends primarily in the celiac ganglion. The lesser splanchnic nerve originates from thoracic ganglia T9–T10. This nerve joins the aorticorenal ganglion in the abdomen. Dissection of these nerves is not essential.
DO NOT use a scalpel in this area. It is extremely important NOT to puncture the intestines! If the intestines are punctured, report it to your instructor immediately so steps can be taken to avoid fecal matter entering the abdomen.

PROCEDURE: Position the cadaver supine.

1. Study in the atlas the position of the viscera in the abdomen. Read a description of the peritoneal cavity before proceeding with dissection.

2. Reflect the anterior abdominal wall proximal toward the thorax. With your fingers, gently free the abdominal contents from any adhering peritoneum that prevents turning the anterior abdominal wall proximally. Be careful not to disturb the position of the structures.

3. Identify:
   a. diaphragm
   b. liver
   c. gallbladder
   d. stomach
   e. small intestine
   f. ascending colon
   g. transverse colon
   h. descending colon

   Note the position of these structures in relation to one another Figure 36.1.

4. The falciform ligament is found on the liver separating the left and right lobes. Its proximal portion attaches to the peritoneum covering the inferior surface of the diaphragm. This ligament extends from the inferior border of the liver to the umbilicus. The ligamentum teres is the tough round cord found at the free end of the falciform ligament. In fetal circulation, the umbilical vein carries oxygenated blood from the umbilical cord to the liver. The obliterated umbilical vein, following birth, is referred to as the ligamentum teres (ductus arteriosus) (Figure 35.3).

   Before birth, oxygenated blood passes through the liver and enters the inferior vena cava via the ductus venosus. This duct becomes obliterated at birth and is then called the ligamentum venosum. The ligamentum venosum is located posterior to the liver and does not need to be dissected. Locate the falciform ligament and the ligamentum teres of the liver.

5. A portion of the left lobe of the liver will need to be removed so the porta hepatis and lesser curvature of the stomach may be easily seen. With your fingers, find structures—i.e., ducts, arteries, and veins—ascending to the porta hepatis. Make an incision completely through the liver on the left side of the portal structures and falciform ligament Figure 36.2) DO NOT remove the falciform ligament. The cut portion of the liver can now be removed from the cadaver. Preserve this block of liver so it can be replaced at the end of dissection.
Figure 36.1 Structures of the gastrointestinal tract.
6. With your fingers or a probe, work loose the peritoneum covering the superior surface of the liver.

7. Continue to release peritoneum in order to view the pylorus and the superior portion of the duodenum, which is deep to the gallbladder.

8. Lift the greater omentum to find the transverse colon, and note the mesentery of the small intestines with its rich blood supply. See Figure 36.3. The greater omentum attaches to the greater curvature of the stomach and proximal part of the duodenum, hangs down over the intestines as an apron to help hold them in position, and then folds back to attach to the transverse colon and its mesentery.

9. Identify:
   a. jejunum
   b. ileum
   c. cecum
   d. appendix (vermiform process)
   e. ascending colon

10. Follow the ascending colon to the right colic (hepatic) flexure, where it becomes the transverse colon. Locate the left colic (splenic) flexure where the descending colon begins. Identify the sigmoid colon in the lesser pelvis.

THE STOMACH

1. With the cut portion of the left lobe of the liver removed, identify on the stomach:
   a. greater curvature
**Figure 36.3** Greater omentum: (a) the greater omentum covering the intestines; (b) the greater omentum turned toward the thorax to expose the intestines.
b. lesser curvature  
c. pylorus

2. Study a description of the arterial branches of the celiac trunk in an atlas. These vessels are found in the lesser curvature of the stomach and come immediately off of the abdominal aorta.

3. Continue to release the remaining tissue from the lesser curvature of the stomach carefully to better view the esophagus as it enters the stomach. This tissue is referred to as the lesser omentum and connects the lesser curvature of the stomach and the proximal part of the duodenum with the liver.

**NOTE TO THE DISSECTOR** The celiac (coeliac) trunk is a branch off the abdominal aorta just inferior to the aortic hiatus of the diaphragm. It gives off arterial branches. The hepatic branch enters the porta hepatis where it divides into right and left hepatic arteries to supply corresponding lobes of the liver. The splenic artery passes horizontally to the left, deep to the stomach to enter the spleen.

**AUTONOMIC NERVOUS SYSTEM—CELIAC PLEXUS**

The autonomic plexuses of the abdomen will be studied with each area. These plexuses receive parasympathetic fibers from the vagus nerve, and sympathetic fibers are derived from the greater, lesser, and lowest splanchnic nerves and from lumbar splanchnic nerves. Sympathetic ganglia are scattered throughout the plexuses, whereas parasympathetic ganglia are located in the walls of the viscera.

These plexuses are named according to the arteries they surround. The celiac trunk, for example, is surrounded by the celiac (solar) plexus of nerves. It is a large autonomic plexus of the sympathetic nervous system. On either side of the artery is a celiac ganglion. The greater and lesser splanchnic nerves, as well as branches from the vagus and phrenic nerves, enter the celiac ganglia. Nerves exiting these ganglia accompany arteries to the liver, spleen, stomach, and renal plexuses. Some filaments go to the testicular and ovarian plexuses, the abdominal aorta plexus, and superior and inferior mesenteric plexuses.

1. The nerve filaments of the celiac plexus to viscera will not be traced on the cadaver. Read a more thorough description of the celiac plexus in a textbook.

2. Because the network of the celiac plexus surrounds the celiac artery, it will be necessary to remove nerves and fascia as needed to have a clear view of the celiac trunk. Identify the hepatic artery and the gastroepiploic artery.

3. Move the stomach aside in order to locate the splenic artery passing posteriorly.

4. Palpate the stomach to determine if it is full. Once it is determined that the stomach is empty, you may cut open the stomach by making incision lines as shown in Figure 36.4 to see the muscular coat lining the wall of the stomach. This is NOT necessary to do on every cadaver.

**THE PANCREAS**

1. The pancreas is found posterior to the peritoneum and is, therefore, “retroperitoneal.” Carefully remove the peritoneum covering the pancreas to study this lobulated gland.

2. The main duct of the pancreas and the common bile duct of the liver join at the head of the pancreas to enter the duodenum Figure 36.5.
Figure 36.4

The stomach. Incision lines for the stomach if instructed to open.

Figure 36.5

Common bile duct and pancreatic duct.
THE SMALL AND LARGE INTESTINES

1. Review the position and extent of the duodenum, jejunum, and ileum. The duodenum is approximately 25 cm long, curving first superiorly, then inferiorly, then horizontally to the left to the duodenojejunal flexure. It has no mesentery. The jejunum and ileum are attached to the posterior abdominal wall by a mesentery. The jejunum and ileum are approximately 7 meters in length; the upper two-fifths is considered to be jejunum. There is no line of demarcation separating the jejunum from the ileum that can be seen readily; however, changes in the circular folds on the interior do occur. The ileum ends at the ileocecal valve.

2. Find where the ileum ends and the large intestine begins. Identify the cecum. DO NOT clip open the intestine at this point to view the ileocecal valve. Review the position of the appendix in relation to these structures if it is present.

3. The large intestine is approximately 1.5 meters in length. Review the position of the ascending colon, right colic (hepatic) flexure, transverse colon, left colic (pancreatic) flexure, descending colon, and sigmoid (pelvic) colon. The sigmoid colon begins at the inlet of the lesser pelvis.

4. Move aside the intestines in order to view the abdominal aorta.

5. The superior mesenteric artery branches off the abdominal aorta just inferior to the celiac trunk. It loops over the left renal vein. Find the superior mesenteric artery on the abdominal aorta (Figure 36.6). This artery is found by lifting the intestines up and toward the chest to view the aorta. The superior mesenteric artery is found coming off
the aorta under the intestines. This artery passes into the mesentery. The superior mesenteric artery is blood supply to a portion of the duodenum, jejunum, ileum, cecum, ascending colon, and most of the transverse colon.

**AUTONOMIC NERVOUS SYSTEM—SUPERIOR MESENTERIC PLEXUS**

The stem of the superior mesenteric artery is surrounded by nerve fibers. This superior mesenteric plexus is a continuation of the celiac plexus. **Function:** It sends fibers to the pancreas, jejunum, ileum, and parts of the large intestines. It is not necessary to dissect the fibers of this plexus.

**AUTONOMIC NERVOUS SYSTEM—INFERIOR MESENTERIC PLEXUS AND AORTIC PLEXUS**

Nerve fibers from lumbar splanchnic nerves enter the abdominal aortic plexus surrounding the abdominal aorta and the inferior mesenteric plexus surrounding the inferior mesenteric artery. These plexuses also receive fibers from the celiac ganglia.

Filaments from the inferior mesenteric plexus supply the transverse, descending, and sigmoid colons and the rectum. Filaments of the aortic plexus are distributed to the inferior vena cava, the inferior mesenteric plexus, and superior and inferior hypogastric plexus. The hypogastric plexus innervates the ovarian plexus and common iliac (superior) and the pelvic viscera (inferior). It is not necessary to dissect these plexuses on the cadaver. Cranial nerve X, the vagus nerve, is the parasympathetic innervation for abdominal viscera. The preganglionic fibers synapse on ganglia found in the walls of the viscera.

1. The inferior mesenteric artery branches from the abdominal aorta superior to its abdominal division into common iliac arteries. Find the inferior mesenteric artery on the abdominal aorta (Figure 36.6). This artery passes into the mesentery of the left third of the transverse colon, the descending colon, and the sigmoid colon, which it supplies.

2. The hepatic portal system conveys blood from the intestines, spleen, pancreas, and gallbladder to the liver. Three tributaries drain into the portal vein:
   a. The **splenic vein** is located posterior to the pancreas, where it passes from the spleen toward the right to enter the portal vein. Locate this vein slightly inferior to the splenic artery (Figure 36.7).
   b. The **superior mesenteric** vein receives tributaries from the small intestines, cecum, and the ascending and transverse portions of the large intestines. This vein is seen on the right of the superior mesenteric artery. It joins the splenic vein to form the portal vein deep to the neck of the pancreas. Locate the superior mesenteric vein (Figure 36.7).
   c. The **inferior mesenteric vein** receives blood from the descending colon, sigmoid colon, and rectum. It is found on the left side of the body and joins the splenic vein. Identify the inferior mesenteric vein (Figure 36.7).

**THE SPLEEN**

1. Locate the spleen posterior to the stomach near the diaphragm.

   **NOTE TO THE DISSECTOR** The spleen is a highly vascular structure. It is covered by an external serous coat formed by peritoneum. It is associated functionally with the storage of erythrocytes, circulating lymphocyte production, the immune response, and phagocytosis. The dissector may choose to slice open a portion of the spleen to view its inner trabeculae.

2. Identify the splenic artery and vein at the hilus of the spleen.
THE LIVER AND GALLBLADDER

1. With your fingers, work loose the attachments of the peritoneum on the posterior and superior surface of the remaining portion of the liver so the liver can be moved aside with more ease.

2. Replace the cut portion of the left lobe of the liver to study the relationship of the liver to surrounding structures.

3. Identify the gallbladder if present. Locate the cystic duct.

4. The porta hepatis is a deep fissure on the inferior surface of the liver through which the portal vein, common hepatic duct, and hepatic artery enter the liver. Locate these three structures. The hepatic plexus of nerves from the celiac plexus also enters the liver at this point. The nerves do not need to be dissected.

5. Find where the common hepatic duct and cystic duct empty into the common bile duct (Figure 36.5). Trace the common bile duct as it descends posterior to the duodenum and the head of the pancreas. The common bile duct then enters the wall of the duodenum in close association with the pancreatic duct.

6. On the posterior surface of the liver, find where the hepatic veins drain into the inferior vena cava Figure 36.7. These veins will need to be cut where they enter the inferior vena cava.
Abdominal Contents

cava for better viewing of this area. The hepatic veins collect blood from the liver and emerge on the posterior surface to immediately enter the inferior vena cava. Because they are in direct contact with hepatic tissue, they do not appear as veins separate from the liver but rather within the substance of the liver.

STRUCTURES ON THE POSTERIOR ABDOMINAL WALL

1. Move aside abdominal viscera as needed to identify the following arteries (Figure 36.6):
   a. common iliac
   b. external iliac
   c. internal iliac
   d. testicular (or ovarian)

2. Locate the following (Figure 36.7):
   a. inferior vena cava
   b. common iliac veins
   c. external iliac veins
   d. internal iliac veins

3. Study the relationship of the abdominal aorta to the inferior vena cava. Note the level at which the abdominal aorta divides into the common iliac arteries and the position of the common iliac arteries in relation to the common iliac veins.

AUTONOMIC NERVOUS SYSTEM—SYMPATHETIC TRUNK

The sympathetic trunk continues into the abdomen and is located anterolateral to the bodies of vertebrae and medial to the psoas muscle. The inferior vena cava must be held aside to see the sympathetic trunk on the right. Four lumbar splanchnic nerves pass from the ganglia to join the celiac, abdominal aortic, and superior hypogastric plexuses. Its rami communicants join the lumbar nerves.

1. The thoracic duct was traced in the thorax. In the abdomen, much of the lymph from the lower portions of the body collects into the cisterna chyli located on the first and second lumbar vertebral bodies. The cisterna chyli is a sac-like dilation in the lymphatic system located immediately to the right and posterior to the abdominal aorta. The upper end of the cisterna chyli narrows to form the thoracic duct. It is easy to destroy the cisterna chyli when removing fascia in the abdomen and searching for other structures. If the cisterna chyli has been removed, the dissector should study the location of this structure of the lymphatic system in an atlas.

2. The kidneys are retroperitoneal—i.e., located posterior to the peritoneum. They are surrounded by adipose connective tissue, which will need to be removed along with the peritoneum. The suprarenal glands are located in the fat found anterior and superior to the kidneys. They are easily destroyed when the fat is removed from around the kidneys. Locate the right and left kidneys. Preserve the suprarenal glands if they are easily located.

3. Beginning at the abdominal aorta, trace the course of the right and left renal arteries (Figure 36.6). Follow the right and left renal veins from the inferior vena cava to the kidneys. Note the difference in length of the right and left renal veins and arteries.

4. At the hilus of each kidney, identify the ureter, renal vein, and renal artery.

5. Trace the ureters to the bladder. The ureters pass distally and medially in front of the psoas major, then cross the external iliac artery to enter the lesser pelvis. The ureters join the bladder on its posterior–inferior surface. As they enter the lesser pelvis, the
ureters course in the extraperitoneal areolar tissue; therefore, peritoneum will need to be removed to follow their course to the bladder.

6. Make an incision through the kidney, separating the anterior portion of the kidney from the posterior portion. Leave the vessels and ureter of the kidney intact. **Figure 36.8**

7. Identify these structures of the kidney:
   a. fibrous capsule
   b. cortical substance
   c. medullary substance
   d. renal pyramids—The pyramids are conical masses located in the renal medulla.
   e. minor renal calyx—Minor calices drain into major calices.
   f. major renal calyx—Major calices empty into the renal pelvis, which narrows to become the ureter.
   g. renal pelvis—This is a narrowing at the base of the kidney.
   h. renal sinus—This is a central recess at the hilus of the kidney. It is filled with the renal pelvis and major calices as well as renal vessels.

**Figure 36.8** The kidney.

No art provided
AUTONOMIC NERVOUS SYSTEM—SUPRARENAL PLEXUS AND RENAL PLEXUS

The suprarenal plexus consists of branches from the celiac ganglia and plexus and the greater splanchnic nerves, which innervate the suprarenal gland to regulate its output. The renal plexus receives filaments from the celiac ganglia and plexus, aorticorenal ganglia, lower thoracic splanchnic nerves and first lumbar splanchnic nerve, and aortic plexus. This plexus enters the kidneys on arterial branches to supply the vessels, renal glomeruli, and tubules with branches to the ureteric plexus. It is not necessary to dissect these plexuses.

1. Follow the inferior vena cava as it passes posterior to the liver, then through the vena caval foramen in the central tendon of the diaphragm to enter the right atrium of the heart.

2. Beginning at the arch of the aorta, follow the thoracic aorta to where it passes through the aortic hiatus of the diaphragm. It then becomes the abdominal aorta.

3. Trace the esophagus from the stomach through the esophageal hiatus of the diaphragm. Continue following the esophagus through the thorax until it passes posterior to the trachea.

4. The quadratus lumborum can now be seen in its entirety when the intestines are lifted up and proximally. Look at the attachments of this muscle and study the action accomplished on the pelvis when the trunk is stabilized. Explain what action would occur on the trunk if the pelvis were stabilized. Review nerve supply to the quadratus lumborum.
It is IMPORTANT to use the atlas for this dissection!

**NOTE TO THE DISSECTOR**  The male and female cadavers will be selected for this dissection. The dissector should observe both male and female cadavers when studying the structures of the pelvis and perineum.

**PROCEDURE:** Position the cadaver supine.

1. Define the boundaries of the greater pelvis and the lesser pelvis on a skeleton.

2. Identify the following muscles on the pelvic floor, and read a description of the actions of these muscles:
   a. coccygeus
   b. levator ani (pubococcygeus and iliococcygeus)
   c. obturator internus
   d. piriformis

3. Find the ventral rami of sacral nerves in the pelvis. See [Figure 37.1](#).

4. Study in an atlas the branches of the internal iliac artery. On the cadaver, locate the following branches (Figure 37.1):
   a. superior gluteal artery—This artery leaves the pelvis through the greater sciatic foramen above the piriformis.
   b. inferior gluteal artery—This branch leaves the pelvis deep to the sacrospinous ligament. It then passes through the greater sciatic foramen to exit below the piriformis.
   c. internal pudendal artery—This artery branches in close association with the inferior gluteal artery. It passes anterior to the piriformis muscle and sacral plexus through the greater sciatic foramen, then posterior to the sacrospinous ligament. It then passes through the lesser sciatic foramen to send branches to the ischiorectal fossa, anal canal, perineum, and urethra.
   d. obturator—This artery accompanies the obturator nerve as it courses toward the obturator groove.

**NOTE TO THE DISSECTOR**  The dissector needs to identify these arteries. It will facilitate location of the superior and inferior gluteal arteries if the dissector first finds the arteries in the gluteal region. Tug gently on each artery in the gluteal area to confirm identification.

**AUTONOMIC NERVOUS SYSTEM—SUPERIOR AND INFERIOR HYPOGASTRIC PLEXUSES**

The superior hypogastric plexus is located at the bifurcation of the abdominal aorta into common iliac arteries. It is formed by branches from the aortic plexus with the third and fourth lumbar splanchnic nerves. It sends filaments to the ureteric and testicular (or ovarian plexus) and to the common iliac artery as well as the inferior hypogastric plexus. It contains
both sympathetic and parasympathetic fibers from pelvic splanchnic nerves. The transverse, descending, and sigmoid colons are supplied by these nerves.

The inferior hypogastric plexus is found medial to the common iliac artery near the rectum, prostate, and bladder in the male. In the female it is found on the sides of the rectum, uterine cervix, vaginal fornix, and bladder. The nerves in this plexus contain sympathetic fibers as well as parasympathetic fibers derived from pelvic splanchnic nerves. Preganglionic sympathetic fibers are from the lower three thoracic and upper two lumbar segments of the spinal cord. The preganglionic parasympathetic fibers are from the second, third, and fourth sacral segments. Branches are distributed to pelvic viscera to form plexuses around the rectum, bladder, prostate, and uterovaginal area. It is not necessary to dissect these plexuses on the cadaver.

**MALE**

1. Locate once again the spermatic cord and follow its course through the superficial inguinal ring.

2. With scissors, clip open the scrotum, following the course of the spermatic cord to the epididymis and testes.

3. Cut open the fascia covering the spermatic cord and note the continuation of fibers of the internal oblique called the cremaster muscle in the spermatic cord.

4. Locate the testicular artery. This artery is a branch off the abdominal aorta.
5. Trace the testicular artery to the inguinal canal where it courses with the spermatic cord to the scrotum.

6. On the posterior-lateral surface of a testis, locate the epididymis. Follow the course of the ductus (vas) deferens in the spermatic cord as it passes through the superficial inguinal ring. It then courses over the external iliac artery and vein toward the posterior surface of the bladder.

7. The bladder will be found pressed up against the pubic bone. Remove peritoneum from the superior surface of the bladder. Work your fingers along the anterior surface of the bladder to free the bladder from the retropubic fat.

8. Open the bladder by making an incision across its surface in a midsagittal plane. Find the orifice of each ureter at the posterior-lateral extremes of the trigone. Locate the internal urethral orifice at the apex of the trigone. The trigone of the bladder is a small triangular area just above the internal urethral orifice.

9. The detrusor muscle makes up the wall of the bladder. The internal urethral sphincter surrounds the internal urethral orifice. These muscle fibers are controlled by efferent parasympathetic fibers arising from S2–4 (pelvic splanchnic nerves) and sympathetic fibers from the lower two thoracic and upper two lumbar segments. The external urethral sphincter of the urethra is supplied by muscular branches from the pudendal nerve.

**NOTE TO THE DISSECTOR**

To facilitate study of the relationship of the structures of the pelvis and perineum, a median sagittal section should be made of the pelvis. The lower limb and pelvis on one side of the cadaver will need to be removed.

10. Place a block under the low back to arch the vertebral column. Make an incision completely through the posterior abdominal wall muscles superior to the crest of the ilium on one side of the cadaver.

11. Locate an intervertebral disc between two lumbar vertebrae and hand saw through the disc.

12. Make a midline incision separating the right and left halves of the penis and scrotum.

13. Make a midline cut with the saw through the pubis, sacrum, pelvic structures, and vertebral bodies until the incision line through the posterior abdominal wall muscles and intervertebral disc is encountered. The entire pelvis and lower limb can now be removed from the rest of the body.

**NOTE TO THE DISSECTOR**

It may be necessary to cut the sigmoid colon to view this area in its entirety. If this is necessary, tie off the colon in two places before cutting into this area. It will be necessary to remove fecal matter from the sigmoid colon and rectum with paper towels to avoid it contaminating the pelvic area and abdomen.

14. Clean debris from the pelvic region. Open the entire course of the urethra through the penis if portions remain closed.

15. Identify:
   a. sigmoid colon
   b. rectum
16. Read a description of the location of the internal anal sphincter and the external anal sphincter muscles. The internal anal sphincter is controlled by the sympathetic nervous system. This muscle surrounds the upper three-fourths of the anal canal. The external anal sphincter is under voluntary control from the pudendal nerve. This muscle has three portions. A subcutaneous portion surrounds the lower anal canal and extends below the lower border of the internal anal sphincter just beneath the skin. The other two portions surround the internal anal sphincter.

17. The pudendal nerve (S2–4) divides into three branches—the inferior rectal nerve, perineal nerve, and dorsal nerve of the penis. Read a description of the course of the pudendal nerve and the areas supplied by its branches. These branches will not be dissected.

18. Move the rectum medially to locate the levator ani muscle, which is found posterior to the rectum in this dissection. Fascia will need to be removed covering these deeper muscles.

19. On the penis identify:
   a. corpus cavernosum
   b. corpus spongiosum
   c. penis
   d. urethra
   e. external urethral orifice
20. Follow the course of the urethra through the cavernous portion, the membranous portion, and the prostatic portion. Note the position of the prostate gland in relation to the prostatic urethra.

21. Move the bladder aside and locate the seminal vesicles, ampulla, and ductus deferens between the bladder and the rectum. Trace the ductus deferens from the epididymis to the prostate.

22. The urogenital diaphragm forms the floor of the anterior half of the inferior pelvic aperture. The posterior half is closed by the pelvic diaphragm, which is made up of the levator ani muscles and the coccygeus muscles. The urogenital diaphragm is a thin sheet of striated muscle located between a superior and inferior layer of fascia spanning the sides of the ischiopubic rami. In the male, the urethra passes through the urogenital diaphragm, which spans the area between the ischial tuberosity and pubic bone. Locate the area of the urogenital diaphragm on a male cadaver.
1. Folds of peritoneum enclose the ligaments and viscera of the female pelvis. The uterus and ovaries are enclosed in these folds, which aid in maintaining the normal position of these structures. The *broad ligament* passes from the uterus to the lateral walls of the pelvis and contains the ovaries and uterine tube. A portion of the broad ligament extends from the uterine tube and ovary to the lateral wall of the lesser pelvis and contains the ovarian vessels. It is called the *suspensory ligament* of the ovary. The *round ligament* begins at the uterus and goes forward and lateral into the inguinal canal where it joins subcutaneous tissue of the labium major. Study pictures of these ligaments in a textbook. If they are not easily located in the cadaver, proceed with the next step of dissection. See Figure 38.1.

2. Remove portions of the peritoneum as needed in order to locate the uterus, uterine tube, and ovaries.

3. Follow the ovarian artery from the abdominal aorta through its course to the ovary. This artery is delicate and easily destroyed.

4. Remove peritoneum from the bladder, and free the bladder from the retropubic fat by working your fingers along the anterior surface of the bladder. The bladder is found pressed against the pubic bone. Cut open the bladder by making an incision across its surface in a mid-sagittal plane. Find the orifice of each ureter at the posterior-lateral...
extremes of the trigone. Locate the internal urethral orifice at the apex of the trigone. The trigone of the bladder is a small triangular area just above the internal urethral orifice.

5. The detrusor muscle makes up the wall of the bladder. The internal urethral sphincter surrounds the internal urethral orifice. These muscle fibers are controlled by efferent parasympathetic fibers arising from S2–4 (pelvic splanchnic nerves) and sympathetic fibers from the lower two thoracic and upper two lumbar segments. The external urethral sphincter of the urethra is supplied by muscular branches from the pudendal nerve.

**NOTE TO THE DISSECTOR** To facilitate study of the relationship of the structures of the pelvis and perineum, a median sagittal section should be made of the pelvis. The lower limb and pelvis on one side of the cadaver will need to be removed.

6. Place a block under the low back to arch the vertebral column. Make an incision completely through the posterior abdominal wall muscles superior to the crest of the ilium on one side of the cadaver.

7. Locate an intervertebral disc between two lumbar vertebrae and saw through the disc.

8. With a saw, make a midline cut through the mons pubis and symphysis pubis, separating the right and left halves of the pelvis.
9. Continue to make a midline cut through the pubis, sacrum, pelvic structures, and vertebral bodies until the entire pelvis and lower limb can be removed (Figure 38.2).

10. Clean debris from the pelvic region. Open the course of the urethra if portions remain closed.

11. Identify:
   a. sigmoid colon
   b. rectum
   c. anal canal
   d. anus

12. Read a description of the internal anal sphincter and the external anal sphincter muscles. The internal anal sphincter is controlled by the sympathetic nervous system. This muscle surrounds the upper three-fourths of the anal canal. The external sphincter is under voluntary control from the pudendal nerve. The muscle has three portions. A subcutaneous portion surrounds the lower anal canal and extends below the lower border of the internal sphincter just beneath the skin. The other two portions surround the internal sphincter.

13. The pudendal nerve (S2–4) divides into three branches—the inferior rectal nerve, the perineal nerve, and the dorsal nerve of the clitoris. Read a description of the course of the pudendal nerve and the areas supplied by its branches. These nerves will not be dissected. Refer to Figure 37.1, which shows the pelvic arteries and sacral plexus.

14. Move the rectum toward the midline to locate the levator ani muscle, which is found posterior to the rectum in this dissection.

15. Identify:
   a. ovaries
   b. uterus
   c. uterine tube
   d. fimbria
   e. cervix

   Note that the uterus is angled forward over the superior surface of the bladder.

16. Study the vagina and note its position in relation to the urethra and rectum. Locate the vaginal orifice.

17. Follow the course of the urethra to the external urethral orifice. Note the difference in the length of the urethra in the female as compared to the urethra of a male.

18. Locate:
   a. labia minor
   b. labia major
   c. clitoris

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**NOTE TO THE DISSECTOR** It may be necessary to cut the sigmoid colon to view this area in its entirety. If this is necessary, tie off the colon in two places before cutting into this area. It will be necessary to remove fecal matter from the sigmoid colon and rectum with paper towels to avoid it contaminating the pelvic area and abdomen.
19. The urogenital diaphragm forms the floor of the anterior half of the inferior pelvic aperture. The posterior half is closed by the pelvic diaphragm made up of the levator ani muscles and the coccygeus muscles. The urogenital diaphragm is a thin sheet of striated muscle located between a superior and inferior layer of fascia spanning the sides of the ischiopubic rami, which runs between the ischial tuberosity and pubic bone. In the female, the urethra and vagina pass through the urogenital diaphragm. Locate the area of the urogenital diaphragm on a female cadaver.