CT Basics
Module 9

For educational and institutional use. This transcript is licensed for noncommercial, educational in-house or online educational course use only in educational and corporate institutions. Any broadcast, duplication, circulation, public viewing, conference viewing or Internet posting of this product is strictly prohibited. Purchase of the product constitutes an agreement to these terms. In return for the licensed use, the Licensee hereby releases, and waives any and all claims and/or liabilities that may arise against ASRT as a result of the product and its licensing.
1. **Title Screen**
   Module 9: Cross-sectional Anatomy of the Chest, Abdomen and Pelvis

2. **License Agreement**

3. **Objectives**
   After completing this module, you will be able to:
   1) Define anatomical terms associated with the structures described in this module.
   2) Name the major structures of the chest, abdomen and pelvis discussed in this module.
   3) Describe the function of each anatomical structure discussed in this module.
   4) Identify the abdominal quadrants.
   5) Locate specific organs or structures on a schematic or computed tomography image.

4. **Introduction**
   All radiologic technologists performing medical imaging and radiation therapy need a strong foundation in human anatomy. However, as technology advances, practitioners in a variety of disciplines and specialties will require an understanding of cross-sectional anatomy.

   This module is designed to provide you with the necessary tools for understanding anatomy in three dimensions. We assume that you have prior knowledge of overall gross anatomy and a working knowledge of radiographic anatomy, especially radiographic baselines and landmarks. In turn, we believe the study of cross-sectional anatomy will enhance your understanding of both gross and radiographic anatomy. We will focus on the thorax, also called the chest, the abdomen and the pelvis in this module.

   Because it would be difficult for a single module to discuss all the anatomy of the human body, we will only identify the location, function and appearance of major structures. We’ll begin the lesson by reviewing the structures located in the region between the neck and the abdomen.

5. **Thorax**
   Many authors identify the thorax as having an inlet and outlet. The thoracic inlet is formed by the first thoracic vertebra, the first pair of ribs and the upper margin of the manubrium of the sternum. The inlet separates the thoracic structures from those in the lower portion, or root, of the neck. The thoracic outlet is found inferiorly, and is covered by the muscular diaphragm. It is bounded posteriorly by the 12th vertebra and anteriorly by the xiphisternal junction and the sloping cartilages of the costal margins.

6. **Thoracic Inlet**
   This axial CT image of the thoracic is approximately at the level of the thoracic inlet. Note the various structures shown on the image.
7. **Thoracic Inlet**
   The axial CT image on this page shows the sternum, rib and thoracic vertebrae at a level slightly lower than the previous image. Note that more of the lung tissue is shown, allowing us to determine that this image is at a lower level in the thorax.
   Just as in the cranium and face, musculoskeletal structures support and protect the vital organs and other structures located in the thorax. Skeletal structures such as the ribs, sternum and thoracic vertebrae protect the heart, great vessels and lungs.

8. **Costal Cartilages**
   The thorax is bounded anteriorly in the sagittal plane by the sternum and the second through seventh pairs of ribs. The 8th through 10th pair of ribs do not attach directly to the sternum, but are connected to the cartilage of the ribs superior to them. Twelve thoracic vertebrae are located in the posterior midline of the thorax. These vertebrae attach to the ribs.

9. **Muscles of the Thorax**
   Many muscles support the thorax. We’re most interested in the muscles that affect intrathoracic volume during respiration and those that form part of the thoracic boundary. These muscles are the intercostals, the levator costarums and the diaphragm. The intercostal muscles, as seen on this page, fill the spaces between the ribs. The fan-shaped levator costarum muscles originate on the transverse processes of the thoracic vertebrae and attach to the ribs immediately inferior to the vertebrae they originate from.

10. **Diaphragm**
    As we mentioned earlier, the diaphragm covers the thoracic outlet. The contractions of the diaphragm enlarge the thoracic cavity vertically during respiratory inspiration. Notice the relationship of the diaphragm to the lungs, as well as to some of the abdominal organs.

11. **Diaphragm**
    The diaphragm has left and right crura (the singular form is crus) that come together to form an opening for the aorta from the thorax to the abdomen. This opening is called the aortic hiatus.

12. **Pleural Cavities**
    The thoracic cavity is divided into the right and left pleural cavities and the mediastinum. The two pleural cavities are the lateral most sites in the thorax and contain the lungs. Continuous serous membranes called pleura line the two cavities, making them completely self-contained.

13. **Lungs**
    The lungs are elongated and expand from superior to inferior. The right lung has three lobes, while the left lung has two. Each lobe of the lungs is separated by fissures. The apex of each lung extends superiorly above the first rib and is situated posterior to the clavicles. The angles of the lungs are their most inferior parts.

14. **Hilum of the Lung**
    Each lung has a hilum, or hilar region, where the bronchi, blood vessels, lymph vessels and nerves enter and exit the lungs. It is a concave indentation on the medial portion of each lung. This image on this page shows the hilum of the right lung.
15. **Mediastinum**
   While the two pleural cavities occupy the lateral portions of the thorax, the mediastinum takes up the central portion of the thoracic cavity. The mediastinum contains numerous structures.

16. **Parts of the Mediastinum**
   The mediastinum is divided into superior and inferior portions. The arch of the aorta, the aortic branches and all structures that pass from the neck into the thorax are found in the superior part of the mediastinum.
   
   The inferior mediastinum is further segmented into anterior, middle and posterior parts. The anterior mediastinum contains only connective tissue, fat and lymph nodes.
   
   The middle mediastinum holds the heart, the root of the ascending aorta, the pulmonary artery, superior vena cava (SVC), inferior vena cava (IVC) and four pulmonary veins. The azygos and hemiazygos veins, descending thoracic aorta, esophagus and thoracic duct are located within the posterior mediastinum.

17. **Practice Question**

18. **Practice Question**

19. **Great Vessels of the Heart**
   The structures known as the great vessels are associated with the heart. These vessels include the aorta and its branches, the vessels of the pulmonary trunk and the vena cava. The aorta is the largest vessel in the arterial system and the largest artery in the body. It is divided into three sections: ascending, arch and descending. The ascending aorta is positioned in the middle mediastinum; the arch is in the superior mediastinum; and the descending aorta is located in the posterior mediastinum.

20. **Ascending Aorta**
   The ascending aorta begins from the outflow tract of the left ventricle of the heart. The aortic (semilunar) valve separates the aorta from the left ventricle. The left and right coronary arteries branch off the aorta almost immediately. We’ll discuss these important vessels later in the module.
   
   After giving off the coronary arteries, the ascending aorta travels superiorly to approximately the level of the sternal angle before transitioning into the aortic arch. The axial CT image on this page shows the ascending aorta.

21. **Aortic Arch and Branches**
   The aortic arch is located to the left of both the esophagus and the trachea. A continuation of the ascending aorta, it initially rises slightly before arching posteriorly and to the left. The arch then travels inferiorly, becoming the descending aorta. The transition into the descending aorta occurs at the level of the fourth and fifth thoracic vertebrae.
   
   Before the transition, three arteries branch from the arch: the brachiocephalic artery, the left common carotid artery and the left subclavian artery. The arch of the aorta is well demonstrated on this contrast-enhanced CT image. Note its relationship to the superior vena cava and trachea.

22. **Branches of the Aortic Arch**
   On this axial CT image, you can see the three branches of the aortic arch just superior to the arch itself. The brachiocephalic artery is sometimes called the innominate artery because it is a single rather than a paired vessel. It also is referred to as the brachiocephalic trunk. This artery is the first,
largest and most anterior branch off the aortic arch. You can see on this image that the brachiocephalic lies anterior to the trachea at its origin.

However, as the vessel travels superiorly, it takes a more lateral position with regard to the trachea. The bifurcation of the brachiocephalic into the right common carotid and right subclavian arteries occurs lateral to the trachea and posterior to the right sternoclavicular articulation. The middle branch off of the aortic arch is the left common carotid artery.

The image on this page shows the location of the left common carotid as left of and slightly posterior to the brachiocephalic artery. In the superior portion of the mediastinum, the left common carotid may be seen anterior to the trachea initially, and then laterally. The left subclavian artery is the third direct branch off the aortic arch.

As seen on the image, the left subclavian artery is the most posteriorly positioned branch of the aorta. The subclavian is located close to the pleura of the left lung as the artery travels through the superior mediastinum.

23. **Descending Aorta**
   In the posterior mediastinum, at approximately the level of the intervertebral disc between thoracic vertebrae four and five, the aortic arch turns inferiorly and becomes the descending thoracic aorta. This axial CT scan shows the transition.

24. **Descending Aorta**
   The ascending and descending portions of aorta are shown on this axial CT image. The image also shows the superior vena cava.

25. **Heart**
   The heart is a hollow, muscular organ located within the middle mediastinum. It is positioned obliquely within the thorax, with most of its mass to the left of the median sagittal plane. This image is a 3-D CT reformation of the heart acquired with a 256-detector row scanner. As you can see, the apex of the heart, which is the lower-most portion of the structure, is made up entirely of the left ventricle.

   The left ventricle is located approximately at the level of the eighth thoracic vertebra (T8), depending on the respiratory phase. It is the main pumping chamber of the heart and has the thickest walls of all of the chambers. The base of the heart is the most superior portion of the organ. It consists almost entirely of the left atrium and its auricular appendage. The left atrium is also the most posterior aspect of the heart.

   It receives blood from the four pulmonary veins through the mitral valve, located on its superior aspect. The location of the valve is normally at the level of the fourth costal cartilage to the left of the sternum. Most of the anterior surface of the heart is formed by the right ventricle. Triangular in shape, the right ventricle receives blood from the right atrium through the tricuspid valve and ejects that blood into the pulmonary trunk through the pulmonary semilunar valve.

   The approximate location of this valve is to the left of the sternum at the level of the third costal cartilage. The interventricular septum is located between the left and right ventricles.

26. **Heart**
   Numerous structures are shown on this axial CT image through the heart, including the right atrium, left and right ventricles with the interventricular septum, and the descending aorta and azygos vein.
27. **Chambers of the Heart**
   This axial CT scan through the heart is called a four-chamber projection because it shows all four chambers of the heart, as well as the interventricular septum.

28. **Blood Supply to the Heart**
   The left and right coronary arteries supply blood to the heart. These arteries arise slightly superior to the origin of the ascending aorta. Remember that the ascending aorta begins just superior to the aortic valve, at the outflow track of the left ventricle. This 3-D CT reformation of the heart displays the origin of both the left and right coronary arteries.
   Note that the left main coronary is quite short—only about 2 to 3 cm in length. The left main coronary artery bifurcates into the left anterior descending (LAD) and circumflex coronary arteries.

29. **Branches of the Left Coronary Artery**
   After the bifurcation, the left anterior descending artery travels within the anterior interventricular sulcus, descending to the apex of the heart and turning posteriorly to join the posterior interventricular branch of the right coronary artery. The LAD and its branches supply blood to the interventricular septum and parts of both the left and right ventricles.
   The circumflex coronary artery travels inferiorly and to the left within the atrioventricular sulcus to the posterior aspect of the heart. Branches off the circumflex supply blood to the left atrium and parts of the left ventricle.

30. **Right Coronary Artery**
   The right coronary artery (RCA) first ascends anteriorly and toward the right. After passing between the right auricle and the pulmonary trunk, the right coronary artery travels inferiorly in the atrioventricular sulcus to the inferior border of the heart. Along its course, the RCA produces branches that supply blood to the wall of the right atrium.
   Its main branch, the obtuse marginal, travels to the apex of the heart, providing blood to the right ventricle. Another branch of the RCA, the posterior interventricular branch, supplies blood to the posterior wall of both the left and right ventricles and part of the interventricular septum.

31. **Pulmonary Circulation**
   Pulmonary circulation is provided by the pulmonary trunk, which originates from the right ventricle. At its origin, the pulmonary trunk is normally situated anterior to the ascending portion of the aorta. As it travels superiorly, the pulmonary trunk takes a more posterior location. At the level of the aortic arch, the trunk bifurcates into the left and right pulmonary arteries. This axial CT scan shows the pulmonary trunk anterior to the ascending aorta, immediately after its origin.

32. **Left and Right Pulmonary Arteries**
   You can see the bifurcation of the pulmonary trunk into the left and right pulmonary arteries on this axial CT image of the thorax.

33. **Vena Cava**
   The superior vena cava and the inferior vena cava are the largest venous structures in the human body. They return blood to the heart from structures above and below the diaphragm. The superior vena cava, also called the SVC, originates within the superior mediastinum from the union of the left and right brachiocephalic veins.
   This merger normally occurs after the left brachiocephalic vein travels to the right, anterior to aorta and the pulmonary trunk, and meets the right brachiocephalic vein. After its formation, the SVC
travels inferiorly in a vertical line and enters the superior portion of the right atrium. The SVC is responsible for returning venous blood from all of the structures superior to the diaphragm, with the exception of the lungs.

The axial CT scan of the thorax on the left shows the right and left brachiocephalic veins, just before they join to form the superior vena cava. The axial CT scan on the right clearly shows the superior vena cava immediately after its origin in the superior mediastinum.

34. **Inferior Vena Cava**

   The inferior vena cava, or IVC, develops in the abdomen during embryogenesis. It travels superiorly to the right of the median sagittal plane before entering the thorax. To enter the middle mediastinum, the IVC passes through the caval hiatus, a dedicated opening in the diaphragm. After traveling through the caval hiatus, the vein enters the most inferior portion of the right atrium at a vertical point almost identical to the superior insertion point of the superior vena cava.

   The IVC is responsible for returning blood to the heart from structures inferior to the diaphragm. The IVC is larger than the SVC. This axial CT of the thorax shows the IVC and its relationship to the right auricular appendage, right and left ventricles, and the interventricular septum.

35. **Practice Question**

36. **Practice Question**

37. **Other Structures within the Thorax**

   The thorax contains numerous other structures, including the esophagus, trachea, thoracic duct, azygos veins, the thymus gland and numerous muscles.

38. **Esophagus**

   The esophagus begins as a continuation of the pharynx at the level of the sixth cervical vertebra (C6). As it travels inferiorly through the superior mediastinum, it is normally midline in position and lies between the trachea and the thoracic vertebrae. When the esophagus reaches the posterior mediastinum, it is located anterior and to the right of the descending aorta.

   Lower in the thorax, the esophagus travels to the left and passes through the aortic hiatus to enter the stomach. The axial CT image shown on this page demonstrates the relationship of the esophagus to the trachea in the superior mediastinum.

39. **Esophagus**

   Note the location of the esophagus within the lower mediastinum on this axial CT image of the thorax. It is positioned to the right of the descending aorta, anterior to the thoracic vertebra, and posterior and slightly to the left of the right mainstem bronchus.

40. **Trachea**

   The larynx becomes the trachea at the level of C6. At its beginning and throughout its route, the trachea is positioned anterior to the esophagus. The trachea divides into the left and right main stem bronchi at the level of the sternal angle. This region is known as the carina. The left and right bronchi continue to divide into smaller and smaller segments throughout both lungs.

41. **Bronchi**

   The axial CT image on this page shows the left and right mainstem bronchi.
42. **Thoracic Duct and the Azygos and Hemiazygos Veins**

   The main duct of the lymphatic system is the thoracic duct. It begins in the abdomen as the
cisterna chyli and travels superiorly along with the aorta through the aortic hiatus. This axial CT image
shows the thoracic duct, azygos and hemiazygos veins, and aorta at a point immediately superior to the
aortic hiatus of the diaphragm. The azygos and hemiazygos veins are responsible for venous drainage of
the posterior abdominal and thoracic walls.

   The azygos vein ascends within the thorax to the level of the fourth thoracic vertebra (T4) and
then travels in an arch-like fashion over the right lung before entering the superior vena cava. As it rises,
the azygos is located immediately anterior to the thoracic vertebrae, posterior to the esophagus and to
the right of the aorta.

   After traveling though the aortic hiatus, the hemiazygos vein ascends to the left of the aorta
until it reaches the level of the ninth thoracic vertebra (T9). At that level, the vein crosses the midsagittal
plane, posterior to the aorta and esophagus, before emptying into the larger azygos.

43. **Thymus Gland**

   In infancy and early childhood, the thymus gland is quite prominent. It often is seen on chest
radiographs as a distinct shadow just posterior to the sternum. Its appearance may be misinterpreted as
a mass because the gland seems to widen the mediastinum. The thymus is responsible for developing
and maintaining the immune system. After puberty, the thymus gradually decreases in size and is
normally not noticeable in an adult. In fact, its prominence on adult images is usually due to some type
of disorder that compromises the immune system.

44. **Practice Question**

45. **Practice Question**

46. **Musculature of the Thorax**

   The thorax has numerous muscles, but we won’t discuss all of them in this module. Instead,
we’ll only describe some of the pectoral, superficial back and scapular muscles.

47. **Pectoral Muscles**

   The pectoralis major, pectoralis minor, the subclavius and serratus anterior are considered the
muscles of the pectoral region or anterior chest wall. All of these muscles are associated with movement
of the upper extremities. The pectoralis major originates from the clavicle, sternum and ribs and inserts
on the humerus. Fan-shaped and quite large, the pectoralis major covers the anterior aspects of the
chest wall.

   The pectoralis minor is much smaller and has a more limited distribution. It originates from ribs
three, four and five, and ultimately inserts on the coracoid process of the scapula. This axial CT image
shows both the pectoralis major and minor muscles.

48. **Subclavius Muscle**

   Located posterior to the clavicle, the aptly named subclavius muscle originates from the first rib
and inserts on the mid portion of the clavicle. The subclavius stabilizes the clavicle during movement and
is thought to protect the subclavian vasculature if the clavicle is fractured.

49. **Serratus Anterior Muscle**

   Originating from the first eight ribs, the serratus anterior can either be associated with the
pectoral region or the axilla. This fan-shaped muscle closely adheres to the thoracic wall and inserts on
the scapula along its medial border. Its primary function is to help stabilize the scapula. You can see the location of this muscle on this axial CT image.

50. **Other Muscles Associated with the Thorax**
In addition to the muscles of the pectoral region, other muscles include the superficial back, deep back and scapular muscles. The two superficial back muscles are the trapezius and latissimus dorsi. The trapezius originates on the occipital bone and ends at the spinous process of the 12th thoracic vertebra (T12). It inserts on both the clavicle and the scapula.

The latissimus dorsi begins at the spinous process of the 12th thoracic vertebra and extends down to the sacrum. In the thorax, fibers from latissimus dorsi come together as a tendon and insert on the clavicle and scapula.

51. **Deep Back Muscles of the Thorax**
The levator scapulae, rhomboideus major and rhomboideus minor make up the deep back muscles of the thorax. These muscles work together to control and stabilize the movement of the scapula. The three originate from the vertebral column and insert on the medial borders of the scapula. You can see the levator scapula on this axial CT scan.

52. **Rhomboid**
This axial CT image of the thorax shows a rhomboid muscle.

53. **Muscles Associated With the Scapula**
The deltoid, subscapularis, infraspinatus and supraspinatus, and teres major and minor muscles are associated with the scapulae. All these muscles run between the scapula and the humerus.

54. **Deltoid Muscles**
The deltoid muscles cover the shoulder regions and are responsible for their shape. The origins of the deltoid are the spine, acromion of the scapula and the clavicle. The deltoid’s insertion point is the humerus. Note the location of the deltoid on this axial CT scan of the shoulder.

55. **Subscapularis Muscle**
The subscapularis muscle is located within the subscapular fossa along the costal surface. The subscapularis is one of the muscles of the rotator cuff. Other rotator cuff muscles include the infraspinatus, supraspinatus and teres minor. The muscles of the rotator cuff maintain the position of the head of the humerus within the glenoid fossa. The subscapularis muscle is shown in this axial CT image.

56. **Infraspinatus and Supraspinatus Muscles**
The infraspinatus and supraspinatus muscles are located in the infraspinatus and supraspinatus fossae. Both are seen on this axial CT through the region of the scapula.

57. **Teres Major and Minor Muscles**
The oval-shaped teres major muscle originates on the inferior angle of the scapula and joins the tendon from the latissimus dorsi before inserting on the intertubercular groove of the humerus. Teres minor runs along the lateral border of the infraspinatus muscle. The axial CT scan on this page shows the teres major and teres minor muscles.

58. **Practice Question**
59. Practice Question

60. Abdomen
   In this portion of the module, we’ll discuss sectional anatomy specific to the abdomen and pelvis, also referred to as the abdominopelvic cavity.

61. Diaphragm
   As we discussed in an earlier part of the module, the diaphragm is a muscular partition separating the thoracic cavity from the abdominopelvic cavity. This area is called the thoracic outlet. The phrenic nerve controls the movement of the diaphragm. If the phrenic nerve is severed or severely compromised, the diaphragm stops contracting, causing the injured individual to become ventilator dependent.

   As the diaphragm contracts, the thoracic cavity enlarges vertically. When individuals are in the supine position, the diaphragm extends superiorly to approximately the level of the fifth intercostal space. Three large openings in the diaphragm allow structures to pass between the thorax and abdomen. Although the diaphragm also contains several smaller openings, for our purposes, we’ll only discuss the three largest ones. Each of these openings is called a hiatus.

62. Diaphragmatic Openings
   The most anterior and superior of the openings in the diaphragm is the caval hiatus. Located at the level of the eighth thoracic vertebra (T8) about 3 cm to the right of the midsagittal plane, the wide caval hiatus allows the inferior vena cava to pass from the abdomen into the thorax. This hiatus also accommodates the right phrenic nerve and various lymph vessels.

   In a small percentage of individuals, the right hepatic vein also may travel through the caval hiatus before entering the inferior vena cava. The oval-shaped esophageal hiatus is at the level of the 10th thoracic vertebra (T10), about 2 to 3 cm to the right of midline. The esophageal hiatus allows passage of the esophagus and vagus nerve, and esophageal portions of the left gastric vascular system.

   The most posterior of the openings within the diaphragm is the aortic hiatus. The long, oblique aortic hiatus normally is located at the level of the 12th thoracic vertebra (T12) and is actually not a true opening in the diaphragm. It is formed by the space created anterior to T12, between the left and right crura of the diaphragm. The aorta is usually located slightly to the left of midline at this level.

   Other structures that may be seen within the aortic hiatus include the azygos vein, hemiazygos vein and the thoracic duct. This axial CT scan through the superior abdomen demonstrates the left and right crura of the diaphragm and the aortic hiatus containing the aorta and azygos vein.

63. Aortic Hiatus
   The circle on this axial CT scan shows where the crossing of the left and right crura create the aortic hiatus.

64. Practice Question

65. Practice Question

66. Abdominal Walls
   The walls of the abdomen can be divided into two sections: anterolateral and posterior. The walls are composed primarily of skin, fascia and muscles. The muscles of the anterolateral wall include the rectus abdominis, external and internal obliques, and the transversus abdominis. The posterior wall of the abdomen not only is made up of skin, fascia and muscles, but it also consists of bone.
The five lumbar vertebrae compose the middle internal aspects of the wall. The vertebrae are surrounded by the psoas major, iliacus and quadratus lumborum muscles. For the sake of our discussion, we’ll talk about each muscle group separately.

67. **Anterolateral Abdominal Wall**
   The anteriorly positioned rectus abdominis muscle is oriented vertically and runs the entire length of the abdomen. It is located on either side of the midsagittal plane. Three other muscles can be found along the anterolateral walls: the external oblique, internal oblique and transversus abdominis. The outermost muscle is the appropriately named external oblique.
   Originating from the ribs and extending both interiorly and medially, the external oblique ends in a broad, flat, tendinous section of tissue called an aponeurosis. This tissue attaches to the linea alba along the midsagittal plane of the abdomen, the iliac crest and tubercle of the pubic bone. The inguinal ligament is formed from the aponeurosis of the external oblique muscle. The internal oblique is medial to the external oblique.
   This muscle originates on the iliac crest and travels superiorly and obliquely to its external counterpart before inserting on the inferior borders of the ribs. The aponeurosis from the internal oblique divides into two layers before enclosing the rectus abdominis. Traveling horizontally and located below the internal oblique is the transversus abdominis muscle. It is the most medial of the three anterolaterally positioned muscles.

68. **Abdominal Muscles**
   This axial CT scan of the abdomen shows the rectus abdominis and the external oblique muscles in their anatomical positions along the anterolateral walls of the abdominal cavity.

69. **Lateral Abdominal Wall Muscles**
   The oval on this axial abdominal CT image indicates the three muscles of the lateral abdominal wall. Remember that the outermost muscle is the external oblique; the next, more medial muscle is the internal oblique; and the innermost, or most medial of the three, is the transversus abdominis.

70. **Posterior Abdominal Wall**
   The posterior abdominal wall is supported by five large, sturdy lumbar vertebrae. In addition, the lumbar vertebrae are surrounded by several muscles. These muscles include the psoas major, iliacus and quadratus lumborum. They are attached to the vertebrae, and also to the ribs superiorly and ilium inferiorly.

71. **Psoas Major Muscles**
   The psoas major muscle originates on the transverse processes of the lumbar vertebrae and their intervertebral discs. This long, thick muscle travels inferiorly and lateral to the lumbar vertebrae before running along the brim of the pelvis. It then travels through the obturator foramen to insert on the lesser trochanter of the femur. This axial CT image of the lower abdomen shows the psoas major muscles adjacent to the lumbar vertebra.

72. **Iliopsoas Muscles**
   The large, triangular iliacus muscle begins at the iliac fossa and inserts along with the psoas muscle on the lesser trochanter. This muscle and the psoas are considered the most powerful muscles used to flex the thigh. Together, the psoas and iliacus are called the iliopsoas muscles.
These muscles have an extremely close anatomical association that often makes them impossible to differentiate on medical images. You can see on this axial CT image of the abdomen that they are indistinguishable.

73. **Quadratus Lumborum Muscle**
   The last of the muscles of the posterior abdominal wall that we’ll discuss is quadratus lumborum. This muscle has its origin on the transverse processes of the lower thoracic vertebrae and the iliac crests. The muscle travels superiorly to its insertion point on the 12th rib and the upper thoracic vertebrae. Its normal location is posterior and lateral to the iliopsoas muscles. Notice the location of quadratus lumborum on this axial CT image of the abdomen.

74. **Practice Question**
75. **Practice Question**

76. **Abdominal Vasculature**
   As with all areas of the human body, the organs and tissues in the abdominopelvic cavity need blood to function and remain viable. The abdominal aorta is the major arterial tree of the cavity, while the major venous structure is the inferior vena cava. In addition, there is the hepatic portal system of veins. Let’s discuss them separately.

77. **Abdominal Aorta**
   Remember that the abdominal aorta begins at the aortic hiatus of the diaphragm where it is normally located slightly to the left of the midsagittal plane. As it continues an inferior course, the vessel takes on a more midsagittal position. The aorta continues inferiorly to the level of the fourth lumbar vertebra (L4) where it bifurcates into the common iliac arteries. Before dividing, the abdominal aorta produces several branches, including the celiac, superior mesenteric, renal, gonadal, lumbar, inferior mesenteric and the median sacral arteries.

80. **Branches of the Celiac Artery**
   The left gastric artery is the smallest branch of the celiac artery. After its origin, the left gastric travels to the left before following a more inferior course that takes it along the lesser curvature of the stomach. Along the way, the artery supplies blood to the cardiac portion of the stomach. Ultimately, the branches of the left gastric join those of the right gastric artery. The hepatic artery is the middle branch of the celiac artery.
The hepatic artery runs to the right, entering the porta of the liver. Along the way, the hepatic produces several other arteries, including the cystic, gastroduodenal and right gastric arteries. After entering the porta hepatis, the hepatic artery bifurcates into the left and right hepatic arteries. The largest and longest branch of the celiac is the splenic artery.

Traveling horizontally toward the left, the splenic runs posterior to the stomach along the superior border of the pancreas before it reaches the hilum of the spleen. Main branches of the splenic artery are found along the pancreas.

81. **Superior Mesenteric Artery**
   Like the celiac artery, the superior mesenteric artery, also known as the SMA, is an unpaired branch of the aorta. Also like the celiac, the SMA originates from the aorta’s anterior surface at the level of the third lumbar vertebra (L3). After its origin, the SMA travels anteriorly and to the left, supplying blood to the descending colon, the distal transverse colon, the sigmoid colon and the rectum.

82. **Suprarenal Arteries**
   Paired suprarenal arteries branch from the lateral surfaces of each side of the aorta at the same level as the origin of the superior mesenteric artery. These arteries travel laterally and superiorly to supply blood to the suprarenal glands.

83. **Renal Arteries**
   At approximately the superior portion of the second lumbar vertebra (L2), the paired renal arteries extend from the lateral surfaces of the abdominal aorta, one on either side like the suprarenal arteries. Each of the renal arteries runs horizontally to enter the hilum of their respective kidneys. The right renal artery is longer than the left because of the orientation of the aorta. The left renal artery is higher than the right because the left kidney is usually positioned higher as well.

84. **Renal Arteries**
   This page shows two axial CT images through the level of the renal arteries. Note the placement of the arteries as they enter the hilum of their respective kidneys.

85. **Gonadal Arteries**
   The paired gonadal arteries start from the lateral walls of the abdominal artery, one on each side. Their origins are just slightly lower than those of the renal arteries. While the renals begin at the upper margin of L2, the gonadal arteries arise at the lower margin of L2. The gonadal arteries are referred to as the ovarian arteries in women and the testicular arteries in men.

86. **Lumbar Arteries**
   Four pairs of lumbar arteries originate from the posterolateral walls of the abdominal aorta at the levels of the first four lumbar vertebrae (L1 - 4). These arteries supply blood to the posterolateral walls of the abdominal cavity.

87. **Median Sacral Artery**
   The median sacral artery arises from the abdominal aorta’s posterior surface just immediately before the aorta bifurcates into the common iliac arteries at L4. The median sacral travels inferiorly, giving off a pair of lumbar arteries that, along with the other lumbar arteries, provide blood to the posterior wall of the abdomen.
88. **Common Iliac Arteries**
   The common iliac arteries are the result of the bifurcation of the abdominal aorta at L4. The common iliacs continue inferiorly to approximately the level of L5 before dividing into the internal and external iliac arteries. The internal iliac arteries supply blood to the gluteal region, perineum, and the viscera and walls of the pelvis. The external iliac arteries supply blood to the lower extremities.

89. **Inferior Vena Cava**
   The inferior vena cava is formed by the union of the left and right common iliac veins at about the level of the fifth lumbar vertebra (L5). The IVC travels superiorly along the right side of the vertebral column to about the 12th thoracic vertebra (T12), the location of the caval hiatus of the diaphragm. Unlike most other true veins, the IVC does not contain valves. Many other veins contribute blood to the IVC as it travels to the caval hiatus.
   IVC tributaries include the common iliac, hepatic, inferior phrenic, lumbar, renal, right gonadal and right suprarenal arteries. The IVC tributaries drain blood from the areas that are supplied by arteries bearing the same names as the veins. This axial CT image through the pelvis shows the common iliac veins immediately before they join to form the inferior vena cava.

90. **Inferior Vena Cava**
   The axial CT image on this page shows the inferior vena cava immediately after its origin at approximately L5.

91. **Inferior Vena Cava**
   You can see the relationship of the inferior vena cava and the aorta on this axial CT image of the upper abdomen. This image was acquired just before the caval hiatus where the IVC meets the superior vena cava.

92. **Veins of the Hepatic Portal System**
   The hepatic portal system of veins is responsible for transporting blood from the gastrointestinal system to the liver so that it can be returned to the inferior vena cava. The veins of this system include the inferior and superior mesenteric and the splenic. These three veins empty into the hepatic portal vein, also referred to as the portal vein.
   After the portal vein enters the liver, it branches until it forms the liver sinusoids. Blood from the sinusoids is carried to the central veins, which anastomose to create the hepatic veins.

93. **Portal Vein**
   Posterior to the neck of the pancreas, at the level of the second lumbar vertebra, the superior mesenteric and splenic veins merge to form the portal vein. The portal vein is approximately 7 to 8 cm in length and is one of the structures referred to as the portal triad. Unlike most other anatomical structures, the liver receives blood from two sources: the portal vein, which supplies 75%, and the hepatic artery, which supplies 25%.
   The portal triad includes the portal vein, main hepatic artery and the common bile duct. Note the portal vein on this axial CT image through the abdomen.

94. **Practice Question**

95. **Practice Question**
96. **Abdominal Organs**
   The abdominopelvic cavity contains numerous structures, most of which are organs. This page shows some of the structures of the abdomen, including the liver, stomach, colon and small intestine.

97. **Abdominal Quadrants**
   For the sake of our discussion, we’ll use the abdominal quadrants seen on this image. RUQ is the right upper quadrant, RLQ is the right lower quadrant, LUQ is the left upper quadrant and LLQ is the left lower quadrant.

98. **Abdominal Organs**
   The abdominal organs include the esophagus, gallbladder, adrenal glands and kidneys, the liver, pancreas, spleen, stomach, small intestine and large intestine.

99. **Esophagus**
   Only a very small portion of the esophagus is located in the abdomen. It is primarily a thoracic structure, originating at approximately the level of C6. The esophagus enters the abdomen through the esophageal hiatus at the T10 level. Forming an indentation or groove in the left portion of the liver, the esophagus enters the stomach at an area called the cardiac orifice.

100. **Stomach**
   As a rule, most imaging professionals are very knowledgeable about stomach anatomy, so we’ll only mention a few facts to refresh your memory. The stomach lies in the anterior portion of the left upper quadrant. It is usually posterior to the right lobe of the liver and anterior to the spleen.
   A hollow structure that requires oral radiographic contrast for full visualization and examination, the stomach varies in size and shape depending on circumstances and an individual’s body habitus. The stomach can be divided into three main parts: the fundus, body and pylorus. The distal portion of the stomach, the pylorus, empties its contents into the small intestine.

101. **Stomach**
   This axial CT slice through the abdomen at the level of the pancreatic tail shows the stomach positioned posterior to the right lobe of the liver.

102. **Liver**
   The liver is the largest solid organ within the abdominopelvic cavity. It is enclosed in peritoneum, with the exception of a triangle-shaped space on its posterior surface called the bare area. The liver is primarily located within the right upper quadrant, although its left lobe extends across midline into the left upper quadrant. The organ consists of four lobes: the left, right, caudate and quadrate.
   The lobes of the liver are mostly separated by fossae containing ligaments composed of folds of peritoneum. The left and right lobes are separated by the fossa containing the falciform ligament. The left lobe is separated from the caudate lobe by a fossa that contains that ligamentum venosum. The inferior vena cava separates the caudate lobe from the right lobe, while the quadrate lobe is separated from left lobe by a fossa containing the ligamentum teres.
   The porta hepatis divides the caudate and quadrate lobes. As we noted earlier, the liver has a unique blood supply. One of the more interesting facts about the liver is that it is capable of regeneration. For example, if an individual donates a portion of his or her liver to another person, the transplanted part will grow to the size of the recipient’s own liver, and the donor’s liver will grow to
occupy the space of the donated portion. Neither liver will be anatomically correct, but both will function normally.

103. **Left and Right Lobes of the Liver**

The axial CT scan of the abdomen on this page shows the left and right lobes of the liver. The falciform ligament is also well demonstrated within its fossa.

104. **Caudate Lobe**

Note the location and appearance of the caudate lobe on this CT scan. It is situated upon the postero-superior surface of the liver, between the fossa for the vena cava and the fossa for the ductus venosus.

105. **Quadrate Lobe**

The quadrate lobe of the liver is very difficult to distinguish on medical images. Its approximate location, delineated here by a circle, is on the underside of the right lobe between the anterior margin of the liver and the porta hepatis. It is situated between the fossa for the gallbladder and the fossa for the umbilical vein.

106. **Gallbladder**

The gallbladder is located along the inferior surface of the liver and near the right surface of the quadrate lobe. A sac-like structure used to store bile, the gallbladder has three parts: the neck, body and fundus. The neck of the gallbladder points toward the porta of the liver. It is continuous with the cystic duct and the most narrow portion of the organ.

The body of the gallbladder is located between the neck and the fundus. The fundus is the most distal part of the organ. Part of the anterior wall of the abdomen, duodenum and transverse colon usually come in contact with the fundus. This axial CT scan of the abdomen shows the gallbladder at its anatomical location.

107. **Spleen**

The spleen is located in the posterior aspect of the left upper quadrant. This highly vascular structure consists of lymphoid tissue and is protected by the 9th through the 11th ribs. The spleen is in close proximity to the left kidney and the transverse colon, while its hilum is located near the tail of the pancreas. Depending on the body habitus of an individual and the distension of the colon and stomach, the spleen varies in size and shape.

108. **Spleen**

The location of the spleen, its hilum and its relationship to the left kidney are shown on this axial CT image.

109. **Pancreas**

The pancreas is a glandular structure located in the posterior aspect of the upper abdomen. It extends from the duodenum to the spleen, spanning both upper quadrants. The pancreas produces insulin from the islet cells, or isles of Langerhans. The organ also manufactures powerful enzymes to aid the digestive process. The enzymes are secreted by the duct of Wirsung, also known as the main pancreatic duct.

The pancreas consists of four parts: the head, neck, body and tail. The head is the organ’s right-most portion. This broad, flattened area is positioned within the c-loop of the duodenum. A small projection on the medial inferior portion of the head is called the uncinate process. The mesenteric
vascular structure is located anterior to the uncinate process. The neck of the pancreas is located to the left of the head. You can identify this part of the pancreas by its tapering appearance.

The union of the superior mesenteric and splenic veins to form the portal vein is posterior to the neck. The neck of the pancreas enlarges to the left, becoming the body. The body lies anterior to the aorta and is separated from the stomach by the omental bursa. The tail is the most posterior and superior portion of the pancreas and the closest part to the hilar areas of the spleen.

110. **Tail of the Pancreas**
    This axial CT image shows the tail of the pancreas. When performing a CT scan of the abdomen from superior to inferior, the tail is the first part that appears.

111. **Body of the Pancreas**
    Just after the pancreatic tail is visible on a superior to inferior CT scan of the abdomen, you can see the body. Note the body of the pancreas on this CT image, just inferior to the first image showing the tail.

112. **Neck of the Pancreas**
    This axial CT image shows the neck of the pancreas, just inferior to the preceding image showing the body.

113. **Head and Uncinate Process of Pancreas**
    When performing a CT scan of the abdomen, as you continue inferiorly, the next portion of the pancreas to appear is usually the head. This axial CT image demonstrates both the head and the uncinate process of the pancreas.

114. **Kidneys**
    The kidneys are paired structures in the posterior one-third of the upper abdomen, positioned just inferior to the diaphragm and each in its own retroperitoneal renal gutter. Red-brown in color and shaped like kidney beans, the upper portion of each organ is protected from injury by the lower ribs. Approximately 6 cm wide and 12 cm in length, the kidneys are located between the 10th thoracic and 3rd lumbar vertebrae.
    The right kidney is usually lower that the left because of the liver’s position, and the location of both kidneys can sometimes vary because of body position and respiration. The kidneys are divided into three poles: upper, mid and lower. The hilum of the kidney is located in the mid, or middle, pole. As you might remember from an earlier discussion, the hilum of an organ represents an area where blood vessels and nerves enter and exit.
    The same is true for the hilum of the kidney, with the exception that ureters exit there as well. The ureters are muscular tubes that transport urine from the kidneys to the urinary bladder. The ureters travel inferiorly from the renal pelvis along the psoas muscles until they enter the bladder on its posterior surface.

115. **Kidneys**
    The hilar regions of both kidneys are shown on this axial CT scan of the abdomen.

116. **Ureters**
    This axial CT image acquired through the pelvis shows the left ureter as it approaches the urinary bladder to insert on its posterior aspect.
117. **Adrenal Glands**
   The adrenal, also called suprarenal, glands are superior to each kidney. The glands are separated from their respective kidneys by a layer of adipose, or fatty, tissue. The glands are usually asymmetrical in appearance. Several authors have described the left as being semilunar in shape, while the right is more pyramidal. The adrenal glands receive their blood supply from the adrenal arteries.

118. **Adrenal Glands**
   The axial CT image on the left shows the right adrenal gland, and the axial CT image on the right shows the left adrenal gland. Both are marked by circles.

119. **Adrenal Gland Variations**
   The adrenal glands don’t always follow the rule of thumb regarding their shapes. The circled adrenal glands shown on this axial CT scan through the upper abdomen are in a reverse configuration described by some authors.

120. **Small Intestine**
   The small intestine, or small bowel, begins at the outlet of the stomach called the pyloric valve. Measuring about 6 to 7 m in length, the small intestine is divided into three sections: the duodenum, jejunum and ileum. After beginning at the stomach, the duodenum loops about 25 cm in the shape of the letter C, encircling the head of the pancreas before continuing as the jejunum.
   Along its path, the duodenum turns and twists, forming superior, descending, horizontal and ascending divisions. The jejunum is the second portion of the small intestine. A tightly coiled tube, the jejunum makes an imperceptible transition into the terminal portion of the small bowel — the ileum. In the right lower quadrant, the ileum empties its contents into the cecum of the colon through ileocecal valve.

121. **Duodenum**
   The axial CT image of the abdomen on this page is enhanced with an oral radiographic contrast medium. Note the relationship of the duodenum to the pancreas.

122. **Ileum**
   This axial CT image of the pelvis shows a portion of the ileum.

123. **Large Intestine**
   Most radiographers are familiar with the large intestine, also known as the large bowel or colon. About 1.5 m in length, this anatomical structure extends from the ileocecal valve to the anus. Located in the right lower quadrant of the abdomen, the cecum is the portion of the colon adjacent to the ileocecal valve. The cecum has a projection off its inferior surface called the appendix. Superior to the cecum is the ascending portion of the colon.
   The ascending colon travels superiority to the level of the liver, where it turns left, forming the hepatic flexure. After the hepatic flexure, the colon runs horizontally at a slight incline, and is known as the transverse colon. At the level of the spleen in the left upper quadrant, the transverse colon makes an inferior turn at the splenic flexure and becomes the descending colon.
   From the splenic flexure, the descending colon continues inferiorly to the level of the iliac crests, where it transitions into the sigmoid colon. The sigmoid travels toward the right, finally positioning itself in midline, anterior to the sacrum. At approximately the third sacral segment, the sigmoid transitions into the rectum. The rectum extends about 12 cm, before becoming the anal canal, a structure about 2.5 to 4 cm in length. The anal canal ends at the anal sphincter.
124. **Colon**  
The axial CT image on this page shows the hepatic flexure, identified by the circle, on the right and the descending colon on the left.

125. **Practice Question**

126. **Practice Question**

127. **Pelvic Organs**  
The pelvis extends from the iliac crests to the symphysis pubis. It contains organs that are common to both women and men, such as portions of the large and small intestines, the rectum, ureters and the urinary bladder. The reproductive organs, however, are different in the male and female pelvis.

128. **Small Intestine**  
The circle on this image encloses the portion of small intestine located in both the female and male pelvis.

129. **Rectum**  
This axial CT image displays the common pelvic structure known as the rectum.

130. **Urinary Bladder**  
The urinary bladder is also common to both men and women. This axial CT image through the lower pelvis shows the urinary bladder.

131. **Reproductive Organs**  
The reproductive organs within the pelvis vary depending on whether the individual is a man or woman. In women, the main reproductive organs are the uterus, fallopian tubes and the ovaries. Ionizing radiation is not generally used to image the reproductive organs, especially during the reproductive years. This axial CT image of a woman outside of childbearing age shows the uterus. You also can see the endometrial stripe marking the endometrium. The fallopian tubes and ovaries often are not specifically identified on CT images and are not seen on this image.

132. **Seminal Vesicles**  
In men, reproductive organs include the seminal vesicles, corpus cavernosum and prostate gland. The seminal vesicles are shown on this axial CT image at the level of the acetabulum.

133. **Prostate Gland**  
This axial CT image through the lower pelvis at the level of the pubic symphysis shows the prostate gland. Notice the anal canal posterior to the gland.

134. **Corpus Cavernosum**  
The corpus cavernosum of the penis is identified on this axial CT image of the male pelvis.

135. **Male Pelvis**  
This sagittal MR image of the male pelvis shows the urinary bladder, rectum, prostate gland and testicles.
136. Image Review
See if you can identify the anatomy on this CT scan. Move your cursor over the image to identify important anatomy.

137. Image Review
See if you can identify the anatomy on this CT scan. Move your cursor over the image to identify important anatomy.

138. Image Review
See if you can identify the anatomy on this CT scan. Move your cursor over the image to identify important anatomy.

139. Conclusion
This ends the lesson on sectional anatomy of the chest and abdominopelvic cavity. You may wish to review the CT images in this module prior to taking the end of module assessment.

140. Acknowledgements

141. Bibliography


142. Bibliography (continued)


143. Objectives