Unit 11: Thoracic Wall and Cavity

Dissection Instructions:

Review the skeleton of the thorax (Plates 178, 179; 1.9A&B, 1.10). The walls of the thorax consist of the 12 thoracic vertebrae, 12 pair of ribs and the sternum. The first seven ribs articulate with the sternum through their costal cartilages and are called true ribs. The five remaining ribs are called false ribs. The eighth, ninth and tenth ribs articulate with the rib above through their costal cartilages. The eleventh and twelfth ribs do not articulate with anything anteriorly and are called floating ribs. The first rib articulates with the sternum by means of a primary cartilaginous joint. All of the other ribs, 2-10, articulate by means of synovial joints. The sternum consists of three parts, manubrium, body and xiphoid process. The manubrium and body meet at an angle, the sternal angle, while the surface of the xiphoid process is recessed compared to the surface of the body. The first rib articulates with the manubrium below the sternoclavicular articulation and usually cannot be palpated. The second rib articulates at the junction of the manubrium and body at the sternal angle. Ribs are counted from the second rib. The costal cartilages of the 7-12th ribs form the costal margin.

Posteriorly the ribs articulate with the vertebrae, usually with the body and transverse process (Plates 178, 189; 1.13). The first rib articulates with the upper part of the body of the first thoracic vertebra close to the pedicle. The part of the rib (Plates 180; 1.11-1.13 ) articulating with the body is called the head of the rib. Adjacent to it is the neck of the rib, which joins the body of the rib. At the junction of neck and body there is a tubercle which articulates with the end of the transverse process of the first thoracic vertebra. The first rib is the shortest, broadest and most curved rib. The superior surface of the body has a tubercle, the scalene tubercle, bounded anteriorly by the groove for the subclavian vein and posteriorly by the groove for the subclavian artery.

The head of the second rib articulates with the lower part of the body of the first thoracic vertebra, the disk between the first and second thoracic vertebra and the upper part of the second thoracic vertebra. Its tubercle articulates with the transverse process of the second thoracic vertebra. Ribs 3 through 10 have similar articulations at appropriate levels. The 11th and 12th ribs usually articulate only with the corresponding vertebrae. The typical ribs have an angle distal to their tubercles which corresponds to the most posterior aspect of the thoracic cavity. On the inner surface near the lower border of the typical ribs is a groove which contains the intercostal vein, artery and nerve. The ribs are not horizontal, rather, they slope inferiorly from posterior and anterior. The top of the sternum (jugular notch) is in a horizontal plane which passes through the intervertebral disc between the second and third thoracic vertebrae. The sternal angle is in a horizontal plane which passes through the intervertebral disc between the fourth and fifth thoracic vertebrae.

The spaces between ribs are designated intercostal spaces (Plates 182, 183, 187, 191; 1.16 – 1.19, Table 1.1 and figures-p. 21) and are named for the rib above. The spaces are closed by the intercostal muscles which attach to adjacent ribs. The external intercostal muscles arise from the rib above and insert at a correspondingly more distal part of the rib below. It begins near the head of the rib but ends near the beginning of the costal cartilages of the ribs. Continuing from the muscle to the sternum is the external intercostal membrane, which can be considered to be the continuation of the epimysium of the muscle. The external intercostal muscles help to stabilize the ribs and probably can aid in inspiration. The internal intercostal muscles arise from the rib below and insert at a more distal point on the rib above. The intercostal neurovascular bundle lies in the substance of the upper part of the internal intercostal muscle, which attaches to the borders of the groove housing the bundle (Plates 183, 187; 1.17, 1.18). Those muscle fibers deep to the bundle are designated the innermost intercostal
muscle, but they can only be distinguished in the upper part of the intercostal space where the bundle separates them. The internal intercostal muscles begin at the sternum and end near the angles of the ribs, where the internal intercostal membrane continues to the heads of the ribs (*Table 1.1 and figures-p 21*).

The intercostal arteries receive blood both anteriorly and posteriorly. The first five or six anterior intercostal arteries are branches of the internal thoracic artery while the remaining ones are branches of the musculophrenic branch of the internal thoracic artery. The first two posterior intercostal arteries are branches of the highest intercostal branch of the costocervical trunk of the subclavian artery. The remaining posterior intercostal arteries are direct branches of the descending aorta.

The intercostal nerves exit the vertebral foramina and pass to the inferior surface of the neck of the corresponding rib, which it then follows.

Study the intercostal muscles, nerves and vessels. Carefully remove intercostal muscles and locate the parietal pleura, which lies internal to the chest wall. Keep the parietal pleura intact while removing the intercostal muscles from the first through sixth intercostal spaces from the sternum to the mid-axillary line. Using your fingers and blunt dissection, separate the pleura from the deep surface of the first through seventh ribs. Clean the internal thoracic vessels located just lateral to the sternum behind the costal cartilages. Note that it is held to the lower true ribs by the transverse thoracic muscle. Detach this muscle.

Using an electric saw, cut through the upper six ribs, beginning with the sixth rib at the mid-axillary line as shown at A in *Figure 11-1*. Cut as many of the upper ribs in the mid-axillary line as possible, but the first and second ribs must be cut more anteriorly to stay anterior to the subclavian vein. The parietal pleura and all structures inside the thoracic cavity should be protected from being cut. Cut through the sternum between the articulations for the sixth and seventh ribs. Detach the origins of the sternohyoid and sternothyroid muscles from the sternum. Carefully free and elevate the sternum and attached ribs. These should be removed, but kept intact to be replaced when you review relationships to the anterior wall.

![Figure 11-1](image-url)
Clean the internal thoracic vessels (Plates 184; 1.20 from the subclavian vessels to where they bifurcate into the superior epigastric vessels and musculophrenic vessels. Look for intercostal branches and anterior perforating branches.

Each lung is enclosed in a double layer of pleura separated by a pleural space (Plates 190, 192-194; 1.26, 1.40). The outermost layer of pleura is the parietal pleura and the innermost layer is the visceral pleura, which is fused to and forms the outer layer of the lung. The lungs, with their pleural coverings, fill the lateral portion of the thoracic cavity. The lungs are separated by the mediastinum, a septum of tissues including the heart, great vessels, esophagus, trachea, primary bronchi, thymus and lymph nodes and vessels. (Plates 192, 207, 208; 1.22, 1.25, 1.43, 1.59).

Make a longitudinal incision through the parietal pleura of each lung to open the pleural cavity (Plates 192–194; 1.22, 1.24, 1.26). The parietal pleura related to the ribs is called the costal pleura. Insert your hand into the pleural cavity anterior to the lung and follow the cavity medially. When your fingers reach the medial extent of the cavity, they are in the costodiaphragmatic recess. The costal pleura changes direction to become the mediastinal pleural at the costodiaphragmatic reflection. When one follows the costodiaphragmatic recess from above downwards, it can be seen that the left and right costodiaphragmatic recess from above downwards, it can be seen that the left and right costodiaphragmatic reflections approach each other at the level of the second rib. They remain close until they reach the fourth rib where the cardiac notch of the left pleural cavity begins. At rib six, the reflection passes laterally and inferiorly to cross the eighth rib at the mid-clavicular line. The reflection reaches the tenth rib at the mid-axillary line and crosses the neck of the twelfth rib posteriorly. The parietal pleura covering the mediastinum is called mediastinal pleura.

The upper pole of the lung is located in the base of the neck and is covered by the cervical pleura. Follow the pleural cavity inferiorly to the diaphragm anterior to the lung. When your fingers reach the end of the cavity, they are in the costodiaphragmatic recess at the costodiaphragmatic reflection. This recess extends about the distance of two ribs below the lower border of the lungs. The parietal pleura fused to the diaphragm is called the diaphragmatic pleura. Adhesions are frequently found between the parietal and visceral pleura. These are the result of some earlier inflammation of the pleura. In a normal individual, the parietal and visceral pleura are separated from each other except at the hilum of the lung and pulmonary ligament, where they are continuous with each other. The hilum of the lung is where the primary bronchi and pulmonary vessels enter or leave the lung.

Note how high the domes of the diaphragm (Plates 192, 193; 1.22, 1.40) are in respect to the thoracic cage. It is not unusual for it to reach the level of the fourth interspace on the right side, slightly lower on the left. Immediately beneath the right dome of the diaphragm is the liver. Needles intended for the pleural cavity should not pierce the diaphragm and enter the liver.

The mediastinum extends from the superior thoracic aperture above the diaphragm below, from the sternum in front to the vertebral column posteriorly and between the mediastinal pleurae of the two sides (Plates 207, 208, 226, 227; 1.21, 1.25, 1.42). A horizontal plane extending through the sternal angle anteriorly and the disk between thoracic vertebrae four and five posteriorly separates the superior mediastinum from the inferior mediastinum. The inferior mediastinum contains the pericardial sac and its contents, which comprise the middle mediastinum. The anterior and posterior mediasitia are located anterior and posterior to the middle mediastinum, respectively.

The superior mediastinum should now be studied (Plates 207, 208; 1.21, 1.42, 1.43, 1.58, 1.59). The remnant of the thymus is the most anterior structure. While this has largely been replaced by fat, it still retains its bilobed shape and it’s blood supply from the pericardiacophrenic vessels. The thymus should be reflected upwards to expose the great vessels. Most anteriorly are the great veins.
Behind the medial end of the clavicle or the sternoclavicular joint is the junction of **internal jugular vein** and **subclavian veins**. They form the **left and right brachiocephalic veins**. The left brachiocephalic vein crosses from left to right while the right brachiocephalic vein continues inferiorly in line with the internal jugular of that side. As these are cleaned, locate and identify the **inferior thyroid vein**, the **left superior intercostal vein** and the **azygos vein**. The inferior thyroid vein empties into the superior aspect of the left brachiocephalic vein near the junction of the two brachiocephalic veins. The **left superior intercostal vein** comes from the posterior wall of the thorax, crosses the aortic arch and enters the inferior aspect of the left brachiocephalic vein. The **left and right brachiocephalic veins** join to form the superior vena cava which carries blood to the right atrium of the heart. The **azygos vein** enters the posterior aspect of the **superior vena cava** immediately before it enters the pericardial cavity.

The **aortic arch** passes obliquely backwards, beginning slightly to the right of the midline and ending to the left of the vertebral column posteriorly (Plates 207, 208; 1.21, 1.42, 1.43, 1.58, 1.59). It has three branches, the **brachiocephalic artery**, **left common carotid artery** and the **left subclavian artery**. The brachiocephalic artery ascends toward the right and ends by dividing into the **right common carotid and subclavian arteries**.

The **right vagus** is lateral to the trachea. The **left vagus** is posterior to the left phrenic nerve and runs in between the left common carotid and left subclavian arteries and lateral to the aortic arch. Vagus nerves pass behind the pulmonary root (Plates 202, 208; 1.43, 1.59-1.61). They will discuss them later.

The **trachea** can be seen behind the thymus gland between the common carotid arteries (Plates 202, 208; 1.43, 1.59-1.61). It descends behind the aortic arch and divides into the two primary bronchi. Behind the trachea is the **esophagus**. The esophagus and other structures in the posterior mediastinum will be studied in Unit 14.

The **heart and portions of the great vessels** are enclosed in the **pericardial sac** which consists of an **outer fibrous layer** and an **inner parietal pericardium**. The **fibrous pericardium** fuses to the superior vena cava, ascending aorta and pulmonary trunk superiority pulmonary veins posteriorly and the diaphragm inferiorly. The **parietal pericardium** is continuous with the **visceral pericardium** which covers the great vessels in the pericardial sac and the heart. Between the parietal and visceral pericardium is the **pericardial cavity**.

Open the pericardial cavity by making a vertical incision in front of the heart, then horizontal incisions through the upper and lower ends of the vertical incision. (Plates 207, 208; 1.43) **Explore the cavity just opened** (Plates 207, 208, 211; 1.44B, 1.57). Note that the **ascending aorta and pulmonary trunk** arise close to each other with the pulmonary trunk anterior and to the left at their origins. **Locate the superior vena cava** inside the cavity. Pass your left index finger between the superior vena cava and the ascending aorta and your right index finger behind and under the pulmonary trunk so that your fingers touch. When they touch, they are in the **transverse sinus of the pericardial cavity**. Now pass your right hand under and then behind the heart until the tips of your fingers reach an obstruction. This should be the venous reflection of pericardium. Your fingers now are in the oblique sinus of the pericardial cavity.

The heart is described as having a **sternocostal surface**, **diaphragmatic surface** and **posterior surface**. The sternocostal and diaphragmatic surfaces are separated by the **acute margin**. This margin or border consists of 2/3 of right ventricle and 1/3 of left ventricle. The **right border of the heart is formed by the right atrium** entirely and the **left border is called the obtuse border**. It consists primarily of left ventricle, but the tip of the left auricle is located at the top of the obtuse border. **The apex of the heart is where the acute and obtuse borders join**. The **base of the heart is the posterior surface and consists primarily of the left atrium**. (Plates 208, 209; 1.21-1.23, 1.40, 1.43).
Place the sternum and ribs back in place on the chest and review the surface projections of the heart (Plates 192; 1.39, 1.40, 1.42). The base of the heart lies at the level of the costal cartilages of the third ribs extending from about 1 cm to the right of the sternum to about 2 cm to the left of the sternum and down to the diaphragm. The right border is located just lateral to the right border of sternum. The acute margin extends from behind the sixth or seventh costal cartilage on the right, across the xiphosternal joint, behind the sixth or seventh costal cartilage on the left to the fifth intercostal space about 8 cm from the mid-line. The pulmonary valve is located near the joint between the left third costal cartilage and the sternum, but its sound can best be heard in the second intercostal space to the left of the sternum. The aortic valve is inferior to the pulmonary valve at the level of the third intercostal space. One listens for its sound in the second intercostal space on the right of the sternum. The mitral or left atrioventricular valve is inferior to the aortic valve and at the level of the fourth costal cartilage. Its sound is best heard over the apex of the heart.

**Be sure to identify all of the following in this unit:**

- thoracic vertebrae
- sternum - manubrium, body & xiphoid process
- rib -head, neck, body & angle
- jugular notch
- sternal angle
- intercostal space
- external intercostal muscle
- external intercostal membrane
- internal intercostal muscle
- intercostal artery, vein & nerve
- innermost intercostal muscle
- internal intercostal membrane
- parietal pleura
- transverse thoracic muscle
- internal thoracic vessels
- superior epigastric vessels
- musculophrenic vessels
- visceral pleura
- mediastinum
- pleural cavity
- costal pleura
- costomediastinal recess
- mediastinal pleura
- costomediastinal reflection
- cervical pleura
- costodiaphragmatic recess
- costodiaphragmatic reflection
- diaphragmatic pleura
- superior thoracic aperture
- inferior mediastinum
- superior mediastinum
- thymus
- internal jugular vein
- subclavian veins
- brachiocephalic veins (rt & lf)
- inferior thyroid vein
- left superior intercostal vein
- azygos vein
- left superior intercostal vein
- superior vena cava
- aortic arch
- brachiocephalic artery
- common carotid artery (rt & lf)
- subclavian artery (rt & lf)
- trachea
- esophagus
- heart -part of great vessels
- pericardial sac
- pericardium -parietal & visceral
- ascending aorta