Unit 12 - Heart and lungs

Dissection Instructions: Heart

Attempt to locate and identify nerves coming to the cardiac plexus (Plate 222; 1.59, 1.62, 1.63). Review the position of the heart in the pericardial cavity (Plates 207, 208; 1.26). Less than an inch above the heart, transect the aorta, pulmonary trunk and superior vena cava. Elevate the heart and locate the inferior vena cava. Carefully transect it. On the sides and behind the heart locate the pulmonary veins. Typically there will be four, two on each side, but the number may be more or less. Cut through the pulmonary veins. Remove the heart from the pericardial cavity by cutting any pericardial reflections that remain.

Study the pericardial reflections on the heart and in the pericardial sac in the thorax (Plates 208, 210, 211; 1.43-1.45). Both the aorta and pulmonary trunk are enclosed in the same arterial reflection. Both venae cavae and all pulmonary veins are enclosed in a single venous pericardial reflection. The part of the pericardial space between the arterial and venous reflections is the transverse sinus and the space inferior to the venous reflection is the oblique sinus.

Look into the aorta and pulmonary trunk and study their valves (Plates 218-220; 1.52-1.55). The pulmonary valve has three cusps, anterior, left and right. They each have a small nodule where they meet. The valves are attached to the wall of the pulmonary trunk. The portion of the wall of the pulmonary trunk related to each cusp is bulged outward creating a sinus. The aortic valve also consists of three cusps, left, right and posterior, and has a sinus related to each cusp. The left and right aortic sinuses give rise to the left and right coronary arteries.

Identify the left and right atria with their auricles and the left and right ventricles (Plates 216, 217; 220; 1.49, 1.51). The atria and ventricles are separated by the coronary sulcus which contains the right coronary artery and the circumflex branch of the left coronary artery (Plates 208, 212; 1.45). The ventricles are separated from each other by the anterior and posterior interventricular sulci containing the anterior and posterior interventricular arteries. The vessels are usually surrounded by fat within the epicardium. Clean the coronary vessels (Plates 212-215; 1.45, 1.48). The right coronary artery branches from the right aortic sinus of the ascending aorta and travels in the coronary sulcus between the right ventricle and right atrium. Within a short distance from its origin, it gives off a branch to the sinoatrial (SA) node. The main trunk is crossed by the anterior cardiac veins. The right coronary then descends to the diaphragmatic surface after being joined by the small cardiac vein. The right coronary artery gives off a marginal branch to supply the acute margin. The vessels continue on the diaphragmatic surface to the posterior interventricular sulcus where the right coronary artery forms the posterior interventricular artery and the small cardiac vein empties into the coronary sinus. The coronary sinus lies in the coronary sulcus between the left ventricle and left atrium. It empties into the right atrium near the inferior vena cava. In the posterior interventricular sulcus is the middle cardiac vein which empties into the coronary sinus.

The left coronary artery arises from the left aortic sinus and enters the coronary sulcus (Plates 212, 215, 1.45, 1.48). It quickly divides into anterior interventricular and circumflex arteries. The anterior interventricular artery descends in the corresponding sulcus to the acute border where it usually passes on to the diaphragmatic surface to anastomose with the posterior interventricular artery. The great cardiac vein begins in the anterior interventricular sulcus, ascends to the coronary sulcus where it travels in company with the circumflex artery to the coronary sinus (Plates 212; 1.46). The circumflex artery gives off a marginal branch to serve the obtuse border and a branch to the posterior surface of the left
ventricle. It ends by anastomosing with the right coronary artery. Occasionally the circumflex artery continues as the posterior interventricular branch, replacing the branch from the right coronary artery.

**Review the circulation of the heart muscle.** The right coronary artery arises from the right aortic sinus, travels in the coronary sulcus to the back of the heart where it ends as the posterior interventricular artery in the sulcus of the same name. It gives off the artery to the SA node and a marginal branch to the acute border. The left coronary artery arises from the left aortic sinus and branches when it reaches the coronary sulcus. The anterior interventricular artery descends in the corresponding sulcus. The circumflex artery travels in the coronary sulcus to the posterior of the heart giving off a marginal branch to the obtuse border and a branch to the posterior surface of the left ventricle.

Blood from the anterior surface of the right ventricle empties directly into the right auricle by means of anterior cardiac veins or by the small cardiac vein which travels in the coronary sulcus to the coronary sinus. The middle cardiac vein travels in the posterior interventricular sulcus and empties in the coronary sinus. The great cardiac vein begins in the anterior interventricular sulcus, enters the coronary sulcus and travels with the circumflex artery to the back of the heart where it expands into the coronary sinus. At that point, the sinus receives the oblique vein of Marshall, which rarely persists as a left superior vena cava.

The portion of the wall of the right atrium between the superior and inferior venae cavae is separated from the rest of the atrium by two sulci. Posterior and to the left is the sulcus where the interatrial wall, the interatrial sulcus is located. Anterior and to the right is the **sulcus terminalis** (*Plates 210; 1.43*).

**Open the right atrium:** on the posterior surface of the heart, make a vertical incision through the wall of the right atrium by cutting from the superior vena cava to the inferior vena cava. Make a second cut from the inferior vena cava along the anterior border of the right auricle to its most anterior superior point (A to B to C in Figure 12-1 and A to B in Figure 12-2). Clean out the right atrium of blood or latex and identify the important structures seen within (*Plates 216; 1.49*). The **valve of the inferior vena cava** directs blood from the inferior vena cava to the **fossa ovalis**, a depression in the interatrial wall. Surrounding the fossa, especially anteriorly, is the **limbus fossa ovalis**. In about 20% of individuals, the fossa ovalis is patent, but as long as left heart pressure exceeds right heart pressure, no leakage occurs between atria. The smooth part of the right atrium is the **sinus venarum**. The wall of the right atrium connecting the superior and inferior venae cavae is smooth, but immediately to the right and anterior is a vertical ridge of cardiac muscle on the inner wall called the **crista terminalis**. This is represented on the outer surface of the wall as the sulcus terminalis. Extending from the crista terminalis to the entire right auricle are **pectinate muscles**. Anterior and to the left of valve of the inferior vena cava is the **valve of the coronary sinus**, guarding the opening of the coronary sinus. Anteriorly is the **right atrioventricular or tricuspid valve**. The valve has three cusps, anterior, posterior and septal. A short distance from the opening of the coronary sinus and adjacent to the septal cusp of the atrioventricular valve is the location of the **atrioventricular (AV) node** (*Plates 221; 1.56*).
Open the right ventricle by an incision beginning at the pulmonary trunk and cutting between the anterior and right cusps of the pulmonary valve (D to E in Figure 12-1) (Plates 216, 220; 1.50, 1.56). Once through the valve, continue the incision toward the acute border and nearly arrive to the border, then turn up about 2 cm away from the border to the coronary sulcus. Clean out the chamber without destroying the chordae tendinae. The ridges of heart tissue on the inner wall of the ventricle are called trabeculae carnae. Projecting from the wall are papillary muscles. The anterior papillary muscle is a big one. The moderator band extends from the interventricular wall to the base of the anterior papillary muscle. On the moderator band you can see the white right bundle branch runs on its surface. There are a couple of posterior papillary muscles on the inferior wall. The septal papillary muscles attach on the right surface of the interventricular septum. The anterior papillary muscle attaches the anterior and posterior cusps of the tricuspid valve through its chordae tendinae. The supraventricular crest separates the right atrioventricular orifice from the pulmonary opening and marks the beginning of the infundibulum or conus arteriosus. The supraventricular crest and the moderator band separate the inflow tract from the outflow tract of the right ventricle.

Open the left atrium by cutting between the inferior and superior pulmonary veins (F to G in Figure 12-2) (Plates 217; 1.51). The internal surface of the left atrium in between the pulmonary veins is smooth. The auricle of the left is small and lined with pectinate muscles. Locate the valve of the foramen ovale in the interatrial wall. Identify the anterior and posterior cusps of the left atrioventricular or mitral valve.

Open the left ventricle from aorta to apex of the heart (X to Y in Figure 12-1) (Plates 217, 220; 1.51, 1.52) Note that the wall of the left ventricle is much thicker than the wall of the right ventricle. Feel the thickness of the interventricular septum by placing your thumb in one ventricle and index finger in the other. Its thickness is nearly same as the left ventricle. The inner wall of the ventricle is covered with trabeculae carnae. Locate the anterior and posterior papillary muscles and follow the chordae tendinae to the adjacent parts of the cusps of the mitral valve. The anterior cusp of the mitral valve separates the inflow tract from the outflow tract (aortic vestibule). The aortic vestibule is the space immediately below the aortic valve and the wall is smooth. Identify the membranous part of the interventricular septum located in between the right and posterior cusps of the aortic valve. Below the membranous part of the interventricular septum, on the left surface of the interventricular septum, you can find white fibers deep to the endocardium. These are the left bundle branch and its fascicules.

The aortic, pulmonary, tricuspid and bicuspid valves of the heart are all attached to fibrous rings which in turn are attached to each other to form the skeleton of the heart (Plates 218, 220; 1.50, 152-155A&B). Note the relationship of the valves to each other. The fibrous tissue in between the aortic, right
and left atrioventricular rings is called the **right fibrous trigone**. The atrioventricular node is located on the right surface of the trigone and the AV bundle passes through the trigone and then runs on the top of the muscular interventricular septum. The musculature of the atria is totally separated from the musculature of the ventricles by the fibrous rings.

The **conducting system of the heart** *synchronizes the heart beat*. Impulses begin in the **SA node**, spreads to both atria, and travel through the wall of the right atrium to the **AV node**. From there it travels through the **AV bundle**, which passes through the skeleton of the heart to reach the interventricular septum. It descends in the walls of the interventricular septum as left and right bundle branches which supply the ventricular musculature.

The atria fill at the same time. Venous blood from the entire body enters the right atrium through the venae cavae. When the ventricles relax, they begin filling, even before the atrium contracts. When the ventricles contract, the atrioventricular valves close, causing the first heart sound. The ventricular contraction stretches the elastic walls of the aorta and pulmonary trunk. At the end of ventricular contraction, the elasticity of the aorta and pulmonary trunk causes a back flow of blood which catch the cusps of the aortic and pulmonic valves, closing them and causing the second heart sound. Blood passes through the following route: right atrium, right ventricle, pulmonary arteries, lungs, pulmonary veins, left atrium, left ventricle, aorta, entire body, venae cavae and back to the right atrium.

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

- pericardial cavity
- aorta
- pulmonary trunk
- superior cava
- inferior vena cava
- pulmonary veins
- transverse sinus
- oblique sinus
- pulmonary valve
- aortic valve
- left & right atria
- auricles
- left and right ventricles
- right coronary artery
- circumflex branch of left coronary artery
- ant and post interventricular sulci
- ant & post interventricular arteries
- right aortic sinus of ascending aorta
- branch to the sinoatrial (SA) marginal branch
- posterior interventricular artery
- small cardiac vein
- coronary sinus
- posterior interventricular sulcus
- middle vein
- left coronary artery
- anterior interventricular arteries
- circumflex artery
- great cardiac vein
- marginal artery
- valve of inferior vena cava
- fossa ovalis
- limbus fossa ovalis
- sinus venarum
- crista terminalis
- pectinate muscles
- valve of the coronary sinus
- right atrioventricular valve (tricuspid)
- atrioventricular (AV) node
- sinoatrial (SA) node
- right ventricle
- trabeculae carnae
- ant, post & septal papillary muscles of right ventricle
- chorda tendineae
- supraventricular crest
- infundibulum - conus arteriosus
- left atrium
- foramen ovale
- left atrioventricular valve - mitral
- left ventricle
- left aortic sinus
- interventricular septum
- trabeculae carnae
- ant & papillary muscles of left ventricle
- aortic vestibule
Dissection Instructions - Lungs and Trachea:

Detach the pericardium from the aorta and pulmonary trunks and study the relationships between the aorta and left primary bronchus and the right and left pulmonary arteries to their respective primary bronchi (Plates 202; 1.61). Note that the ascending aorta is anterior to the right pulmonary artery before it arches over the left primary bronchus to descend behind the root of the lung. Clean the vagus nerve and locate the left recurrent (inferior) laryngeal nerve passing under the aortic arch, to the left of the ligamentum arteriosum, on its way to the groove between the trachea and esophagus (Plates 1.61, 1.63). The right pulmonary artery passes to the right behind the ascending aorta and superior vena cava to enter the right lung anterior to the primary bronchus. The left pulmonary artery passes above the left primary bronchus to reach the left lung. On each primary bronchus, clean the bronchial arteries and find their origin from the descending aorta (Plate 203; 1.63). Attempt to locate and save some of the nerves contributing to the cardiac plexus, such as the superior and inferior cardiac branches of the vagus nerves and the superior, middle and inferior sympathetic cardiac nerves (Plate 205; 1.61).

Clean the brachiocephalic veins, superior vena cava and their tributaries (Plates 202, 208; 1.21, 1.41, 1.59). Behind the left brachiocephalic vein, clean the brachiocephalic, left common carotid and left subclavian arteries. Look for aberrant branches from the aortic arch and brachiocephalic artery. The arch normally has three branches, but may have more.

Review the superior and inferior thyroid arteries and corresponding veins, then clean the thyroid gland (Plates 70-72; 8.17A-C, 8.19-8.21). Note that its isthmus crosses in front of the trachea at the level of the second through fourth tracheal rings. Check to see if there is a pyramidal lobe projecting upward from the isthmus. If so, there may be a muscle, the levator thyroidea, inserting into it from above or a fibrous remnant of the thyroglossal duct.

The trachea (Plates 198, 199, 205; 1.24, 1.31A, 1.32) to the cricoid cartilage above at the level of the CV6 and ends at the level of TV5 by dividing into the left and right primary bronchi. Its upper portion receives its blood supply from the inferior thyroid arteries and its lower portion from bronchial arteries. Behind it is the esophagus. Transect the trachea below the thyroid gland and note that its cartilages are C-shaped and that the posterior portion which is related to the esophagus has no cartilage. Cut through the left primary bronchus and right pulmonary artery. Detach the pericardium from the pulmonary veins. Free the lungs from the parietal pleura and remove them.

The right primary bronchus is larger in diameter, shorter and more vertical than the left primary bronchus (Plates 198, 202; 1.1A, 1.32). Aspirated food is most apt to enter the posterior basal segmental bronchus of the lower right lobe because it is most in line with the trachea. The left primary bronchus is therefore smaller, longer and less vertical than the right primary bronchus.

Compare the relationships at the hilus of the left and right lungs (Plates 195; 1.29, 1.30). For the right lung, the pulmonary artery enters anterior and slightly inferior to the primary bronchus. The pulmonary veins are inferior to the artery. On the left, the pulmonary artery enters the lung above the primary bronchus since it must cross over the bronchus. The veins are again inferior to the artery and primary bronchus. There are several lymph nodes in the hilar region (Plates 204; 1.38). These are filled with black carbon particles.

Study the external surface of the lungs (Plates 194, 197; 1.27). The right lung has three lobes separated by oblique and horizontal fissures. The oblique fissure begins posteriorly above the level of the sixth rib and descends as it comes forward to end on the diaphragmatic surface below the sixth rib. The horizontal fissure begins laterally at the oblique fissure at the mid-axillary line deep to the sixth rib and passes forward to end at the mediastinal surface below the costal cartilage of the fourth rib. The
lobes of the lung may be fused where the fissures should be found. When the horizontal fissure is totally unfused, the pulmonary artery can be found at its depths. The left lung has only two lobes and therefore only an oblique fissure. The upper lobe of the left lung reaches the diaphragm, that portion being called the lingula. Both lungs have costal, mediastinal and diaphragmatic surfaces. The mediastinal surface usually has indentations corresponding to the organs or structures related to that surface (Plates 195; 1.29, 1.30).

Dissecting only from the mediastinal surface, clean the bronchi, arteries and veins of each lung to the branching of the segmental bronchi (Plates 198, 199; 1.28, 1.31, 1.32). For the right lung, the primary bronchus gives rise to three lobar bronchi. The upper lobe bronchus trifurcates into apical, posterior and anterior segmental bronchi. The middle lobe bronchus has only lateral and medial segmental bronchi. The lower lobe has five segmental bronchi. The superior segmental bronchus is directed posteriorly and serves the superior portion of the lower lobe. The other segmental bronchi extend to the diaphragmatic surface and are named medial basal, anterior basal, lateral basal and posterior basal. The right pulmonary artery passes between the upper and middle lobe bronchi to reach the posterolateral aspect of the stem bronchus.

The left lung has only upper and lower lobe bronchi. The upper lobe bronchus divides into two unnamed bronchi which serve the homologs of the right upper and middle lobe bronchi. The upper unnamed bronchus divides into apicoposterior and anterior segmental bronchi and the lower unnamed bronchus divides into superior and inferior lingular segmental bronchi. The lower lobe bronchus has a similar branching to the right lower lobe, except the medial and anterior basal segmental bronchi frequently come off as a single anteromedial bronchus.

Be sure to identify all of the following on the lungs and trachea in this unit:

- aorta
- primary bronchi
- pulmonary arteries
- vagus nerve
- left recurrent laryngeal nerve
- ligamentum arteriosum
- cardiac branches of vagus nerve
- cardiac branches of sympathetic trunk
- brachiocephalic veins
- superior vena cava
- brachiocephalic artery
- left common carotid artery
- left subclavian artery
- trachea
- cricoid cartilage
- hilus of left and right lung of lung
- oblique fissure (left and right)
- horizontal fissure (right)

right lung
- upper lobe
  - apical, posterior & anterior segmental bronchi
  - middle
  - medial and lateral segmental bronchi
  - lower lobe
  - superior segmental bronchus
  - medial basal, anteriobasal, lateral basal, &
    postbasal segmental bronchi
left lung
- lingua
- upper lobe
  - apicoposterior & anterior segmental bronchi
  - superior and inferior lingular segmental bronchi
  - lower lobe
  - medial basal, anterior basal lateral basal, & lobes
  - posterior basal segmental bronchi

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