Make a sagittal incision completely through the thoracic wall 1 cm from the ventral median plane on each side. These incisions should extend from the thoracic inlet through the ninth costal cartilage. The **transversus thoracis** muscle is a flat, fleshy muscle on the medial surface of the costal cartilages of ribs 2 though 8 (Figs. 3-4, 3-6). Its fascicles extend from the costochondral junctions to the sternum. Connect the caudal ends of the right and left sagittal incisions and free the sternum, except for the wide, thin fold of mediastinum that is now its only attachment.

On the right half of the thorax, clean and transect the origin of the latissimus dorsi and reflect it toward the forelimb. Locate and transect the caudal portion of the origin of the serratus ventralis, exposing the ribs. Starting at the costal arch and using bone cutters, *cut only the ribs,* close to their vertebral articulation *within the thorax,* without damaging the sympathetic trunk. Reflect the thoracic wall *without removing it.* As this is done, cut the attachments of the internal abdominal oblique, transversus abdominis, and diaphragm from the ribs along the costal arch. If this is done carefully, the peritoneal cavity will not be opened. Reflect the left thoracic wall in a similar manner.

On the internal surface of the thoracic wall, notice the intercostal vessels and nerves coursing along the caudal border of the ribs. Ventrally, the vessels bifurcate and anastomose with the ventral intercostal branches of the internal thoracic artery and vein. The intercostal nerves supply the intercostal musculature. Their sensory branches were seen as lateral and ventral cutaneous branches.

The **pleurae** (Figs. 3-8, 3-9) are serous membranes that cover the lungs and line the walls of the thorax. These form right and left sacs that enclose the pleural cavities. Each consists of visceral and parietal parts, depending on their location.

The **pulmonary** or **visceral pleura** closely attaches to the surfaces of the lungs, following all their small irregularities as well as the fissures that separate the two lobes.

The **parietal pleura** is attached to the thoracic wall by the endothoracic fascia. This pleura may be divided into costal, diaphragmatic, and mediastinal parts. Each of these is named after the region or surface it covers, and all are continuous, one with another. The **costal pleura** covers the inner surfaces of the ribs and their associated intercostal and transversus thoracis muscles. The **diaphragmatic pleura** covers the cranial surface of the diaphragm. The **mediastinal pleurae** are the layers that cover the sides of the partition between the two pleural cavities. The **mediastinum** includes the two mediastinal pleurae and the space

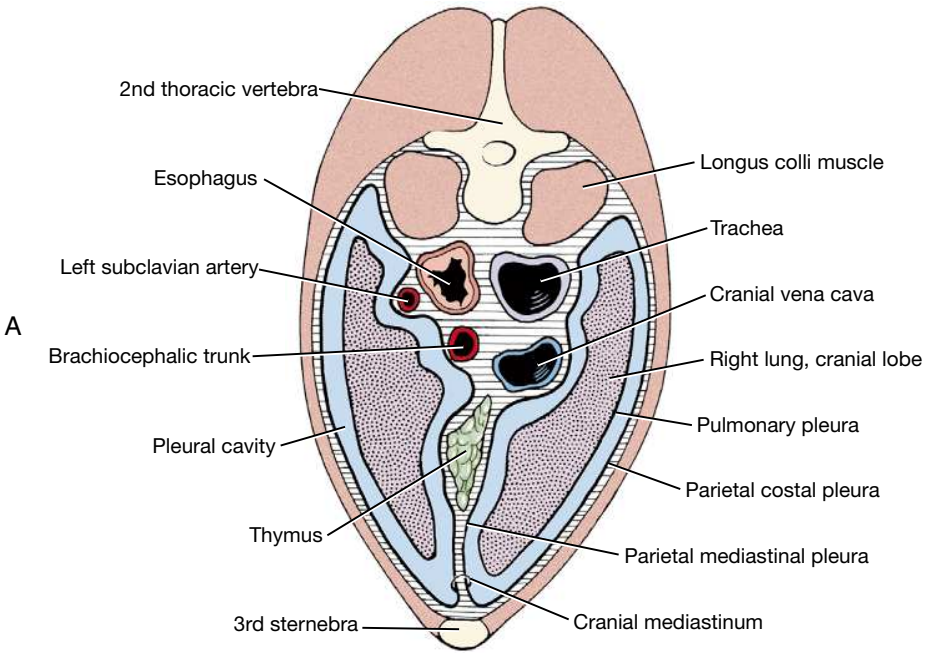


Fig. 3-8 **A**, Schematic transverse section of thorax through cranial mediastinum, caudal view.

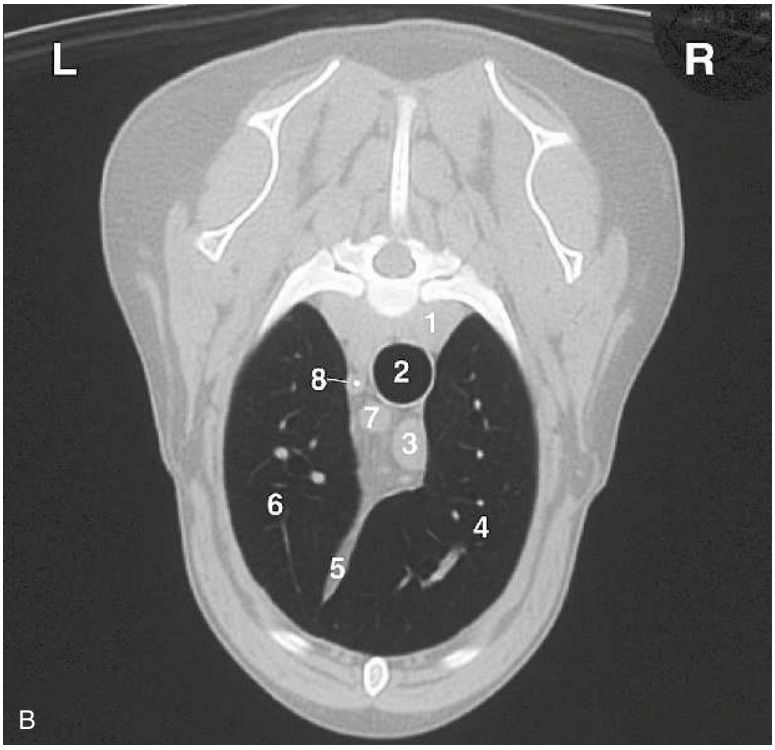


Fig. 3-8—cont'd **B,** CT image, cranial thorax.
1. Longus colli muscle
2. Trachea
3. Cranial vena cava
4. Right cranial lobe
5. Cranial mediastinum
6. Cranial part of left cranial lobe
7. Brachiocephalic trunk
8. Left subclavian artery

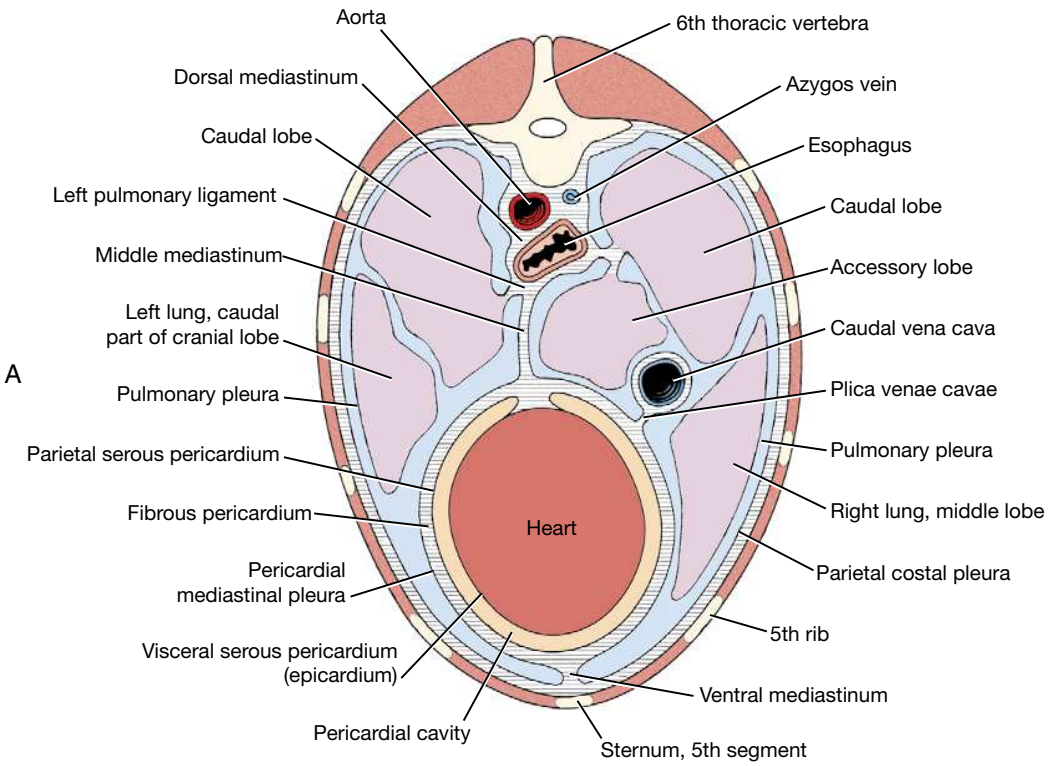
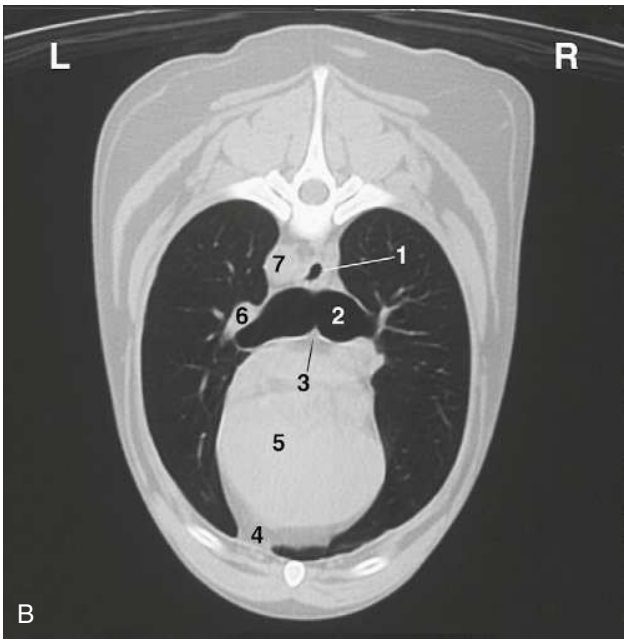


Fig. 3-9 **A**, Schematic transverse section of thorax through heart, caudal view.

(Continued)



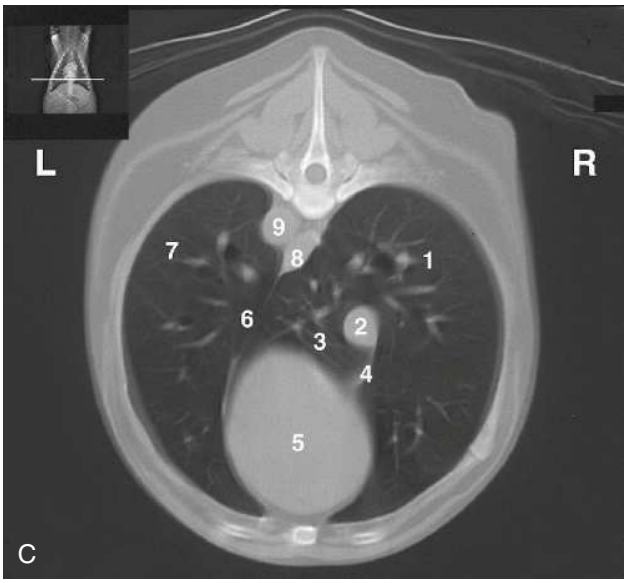


Fig. 3-9—cont'd **B,** CT image, midthorax.
1. Esophagus
2. Right principal bronchus
3. Carina of trachea
4. Ventral mediastinum-phrenicopericardial ligament
5. Heart
6. Left pulmonary artery
7. Aorta

C, CT image, caudal thorax.
1. Right caudal lobe
2. Caudal vena cava
3. Accessory lobe
4. Plica venae cavae
5. Heart
6. Caudal mediastinum
7. Left caudal lobe
8. Esophagus
9. Aorta

between them. Enclosed in the mediastinum are the thymus, the lymph nodes, the heart, the aorta, the trachea, the esophagus, the vagus nerves, and other nerves and vessels. The **pericardial mediastinal pleura** is that portion covering the heart.

The **mediastinum** can be divided into a cranial part, that lying cranial to the heart; a middle part, that containing the heart; a dorsal portion dorsal to the heart; a ventral portion, ventral to the heart; and a caudal part, lying caudal to the heart. The caudal mediastinum is thin. It attaches to the diaphragm far to the left of the median plane. Cranially, it is continuous with the middle mediastinum.

Note the passage of the esophagus through the mediastinum and the esophageal hiatus of the diaphragm. At the esophageal hiatus, a thin layer of pleura, peritoneum, and enclosed connective tissue attaches the esophagus to the muscle of the diaphragm.

The **plica venae cavae** is a loose fold of pleura derived from the right caudal mediastinal portion of the pleural sac that surrounds the caudal vena cava. The **root** of the lung is composed of pleura and the bronchi, vessels, and nerves entering the lung. Here the mediastinal parietal pleura is continuous with the pulmonary pleura. Caudal to the hilus this connection forms a free border, known as the **pulmonary ligament** (Figs. 3-9, 3-10), between the caudal lobe of the lung and the mediastinum at the level of the esophagus. Observe this ligament. In thoracic surgery this must be cut to reflect the caudal lung lobe cranially.

The **thymus** (Figs. 3-8, 3-11, 3-12, 3-14, 3-16, 3-20) is a bilobed, compressed structure situated in the cranial mediastinum. It is largest in the young dog and usually atrophies with age until only a trace remains. When maximally developed, the caudal part of the thymus is molded on the cranial surface of the pericardium.

The **internal thoracic artery** (Figs. 3-14, 3-16 through 3-20) leaves the subclavian artery, courses ventrocaudally in the cranial mediastinum, and disappears deep to the cranial border of the transversus thoracis muscle. It supplies many

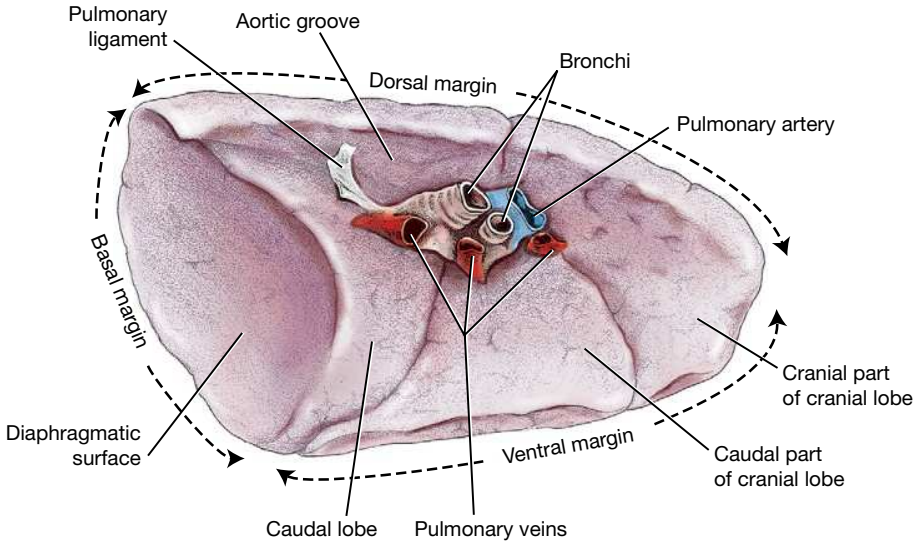


Fig. 3-10 Left lung, medial view.

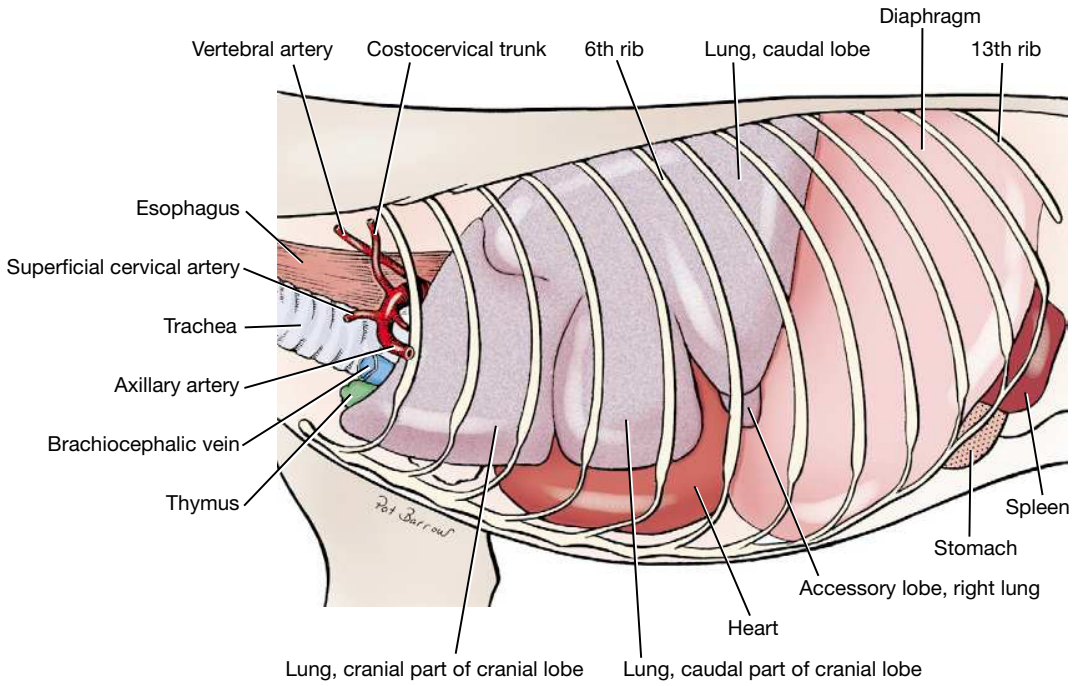


Fig. 3-11 Thoracic viscera within the rib cage, left lateral view.

branches to surrounding structures—the phrenic nerve, the thymus, the mediastinal pleurae, and the dorsal intercostal spaces. The perforating branches to the superficial structures of the ventral third of the thorax have been seen. The anastomoses with the dorsal intercostal arteries on the medial side of the thoracic wall have been seen. Near the attachment of the costal arch with the sternum, the internal thoracic artery terminates in the musculophrenic artery and the larger cranial epigastric artery. The latter has been dissected along with its cranial superficial epigastric branch. The **musculophrenic artery** (Fig. 4-33) runs caudodorsally in the angle formed by the diaphragm and lateral thoracic wall. Dissect its origin. Cut the mediastinum near the sternum and reflect the sternum cranially.

Lungs

Each lung is divided into lobes based on the branching pattern of its principal bronchus into lobar bronchi (Fig. 3-13). The **left lung** (see Figs. 3-10, 3-11) is divided into **cranial** and

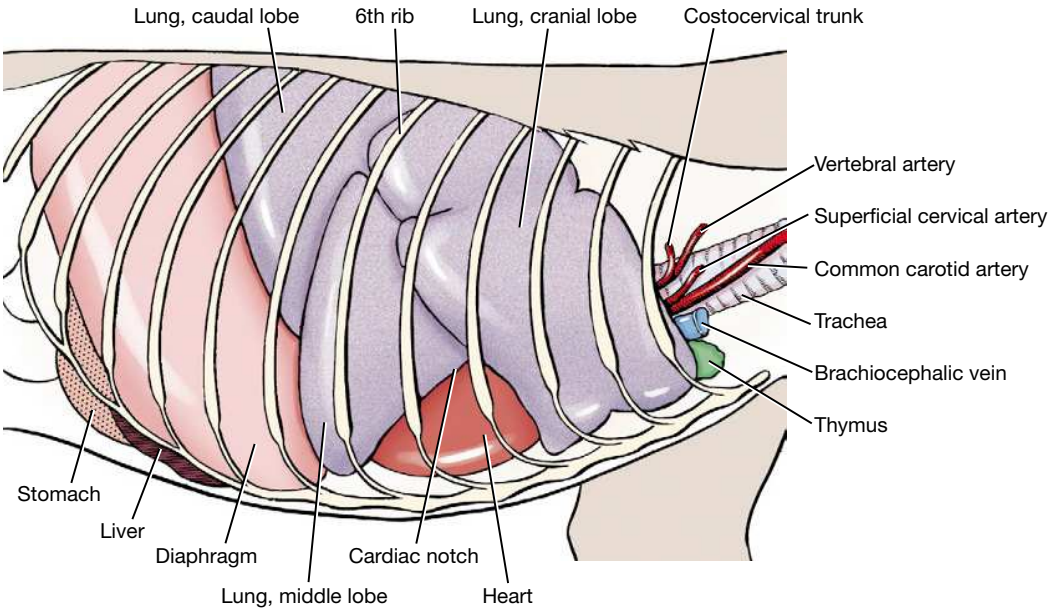


Fig. 3-12 Thoracic viscera within the rib cage, right lateral view.

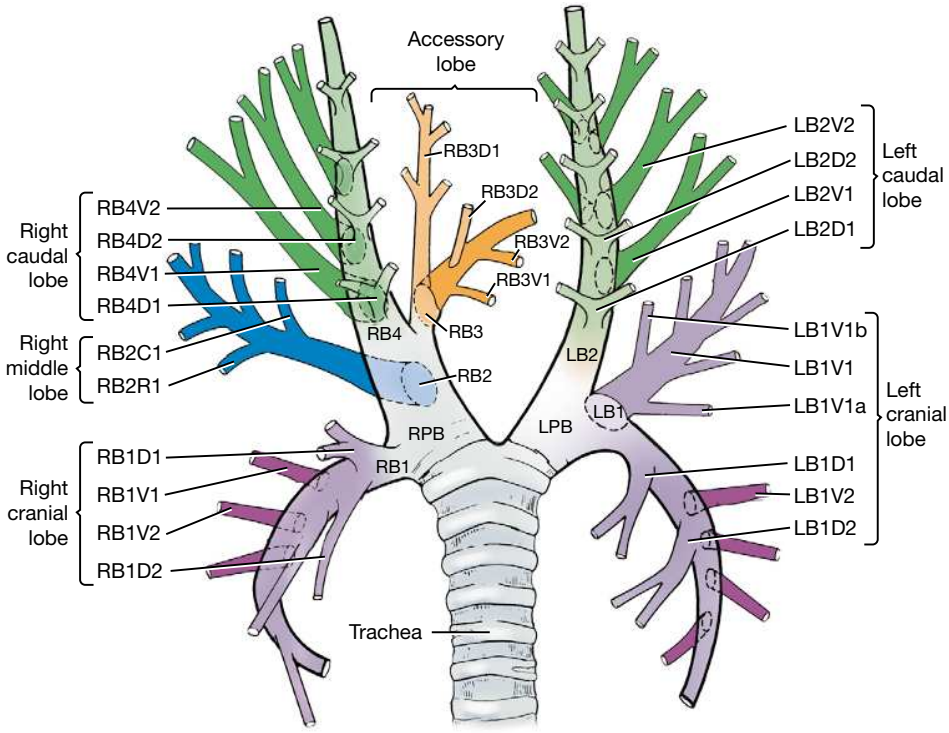


Fig. 3-13 Schematic bronchial tree of the dog, in dorsal view. Letters and numbers identify the principal, lobar, and segmental bronchi by their bronchoscopic order of origin and their anatomical orientation. Lower case *a* and *b* represent subsegmental bronchi (From Amis TC, McKiernan BC: Systematic identification of endobronchial anatomy during bronchoscopy in the dog, *Am J Vet Res* 47:2649–2657, 1986.)

caudal lobes by deep fissures. The cranial lobe is further divided into cranial and caudal parts. The **right lung** (Fig. 3-12) is divided into **cranial, middle, caudal**, and **accessory lobes**. A part of the accessory lobe can be seen from the left through the caudal mediastinum (Fig. 3-20) or from the right through the plica venae cavae, where it lies in the space between these two structures. Reflect the caudal lung lobes to observe this.

Examine the **cardiac notch** of the right lung at the fourth and fifth intercostal spaces. The apex of the notch is continuous with the fissure between cranial and middle lobes. A larger area of the ventral convexity of the heart is exposed on the right side. The right ventricle occupies this area of the heart and is accessible for cardiac puncture here.

Remove the lungs by transecting all structures that enter the hilus. On the right side, this will involve slipping the accessory lobe over the caudal vena cava. Make the transection far enough from the heart so that the vagal nerves crossing the heart are not severed but close enough so that the lobes are not removed individually.

Examine the structures that attach the lungs. The trachea bifurcates into left and right **principal bronchi**. The **carina** is the partition between them at their origin from the trachea. Each principal bronchus divides into **lobar bronchi** that supply the lobes of the lung. Find these on the lungs that were removed. They can be identified by the cartilage rings within their walls.

At the level of the carina, the right principal bronchus gives off the right cranial bronchus to the right cranial lobe of the lung, directly laterally. This is followed by the right middle bronchus that branches off ventrally. The principal bronchus terminates caudally as the accessory bronchus medially and right caudal bronchus laterally. On the left, the left principal bronchus gives off the left cranial bronchus laterally. This divides into cranial and caudal parts, and the left principal bronchus continues caudally as the left caudal bronchus. Within each lobe segmental bronchi branch off the lobar bronchus dorsally and ventrally except for the right middle lobe, where they are cranial and caudal (Fig. 3-13).

Notice that there is usually a single pulmonary vein from each lobe that drains directly into the left atrium of the heart. (The pulmonary veins contain red latex because the specimen was prepared by injecting the latex into the carotid artery. Moving in a retrograde direction, the latex in turn filled the aorta, left ventricle, left atrium, and pulmonary veins. Because latex does not cross capillary beds, there is usually no latex in the pulmonary arteries. Occasionally, the pressure of injection ruptures the interatrial or interventricular septum in the heart, flooding the right chambers with the latex and thus filling the pulmonary arteries as well as the veins.)

The pulmonary trunk supplies each lung with a pulmonary artery. At the root of the lung, the left pulmonary artery usually lies cranial to the left principal bronchus. The right pulmonary artery is ventral to the right principal bronchus. The artery and bronchus are at a more dorsal level than the veins. Using a scissors or scalpel, open a few of the major bronchi to observe the lumen.

Note the **tracheobronchial lymph nodes** located at the bifurcation of the trachea and also farther out on the bronchi.

Determine which structures form the various grooves and impressions by replacing the lungs in the thorax. Observe the long **aortic impression** of the left lung. The most marked impressions on the right lung are on the accessory lobe. This lobe is interposed between the caudal vena cava on one side and the esophagus on the other, and both leave impressions on it. Observe the vascular impressions on the cranial lobes of the lungs and the costal impressions on each lung.

Veins Cranial to the Heart

Carefully expose the larger veins cranial to the heart. Reflect the sternum to one side to facilitate this exposure.

The **cranial vena cava** (Figs. 3-15, 3-17, 3-20, 3-22, 3-35) drains into the right atrium after its formation by the union of the right and left brachiocephalic veins at the thoracic inlet. The **brachiocephalic vein** is formed on each side by the **external jugular** and **subclavian veins**. Usually the last branch entering the cranial vena cava is the **azygos vein** (Fig. 3-14). Only the right azygos vein develops in the dog. The azygos vein may enter the right atrium directly. It is seen from the right in the mediastinal space winding ventrocranially around the root of the right lung. It originates dorsally in the abdomen and collects all of the dorsal intercostal veins on each side as far cranially as the third or fourth intercostal space.

The **thoracic duct** is the chief channel for the return of lymph from lymphatic capillaries and ducts to the venous system. It begins in the sublumbar region between the crura of the diaphragm as a cranial continuation of the **cisterna chyli**. The latter is a dilated structure that receives the lymph drainage from abdominal and pelvic viscera and the pelvic limbs. The thoracic duct runs cranially on the right dorsal border of the thoracic aorta and the ventral border of the azygos vein to the level of the sixth thoracic vertebra. (It may not be

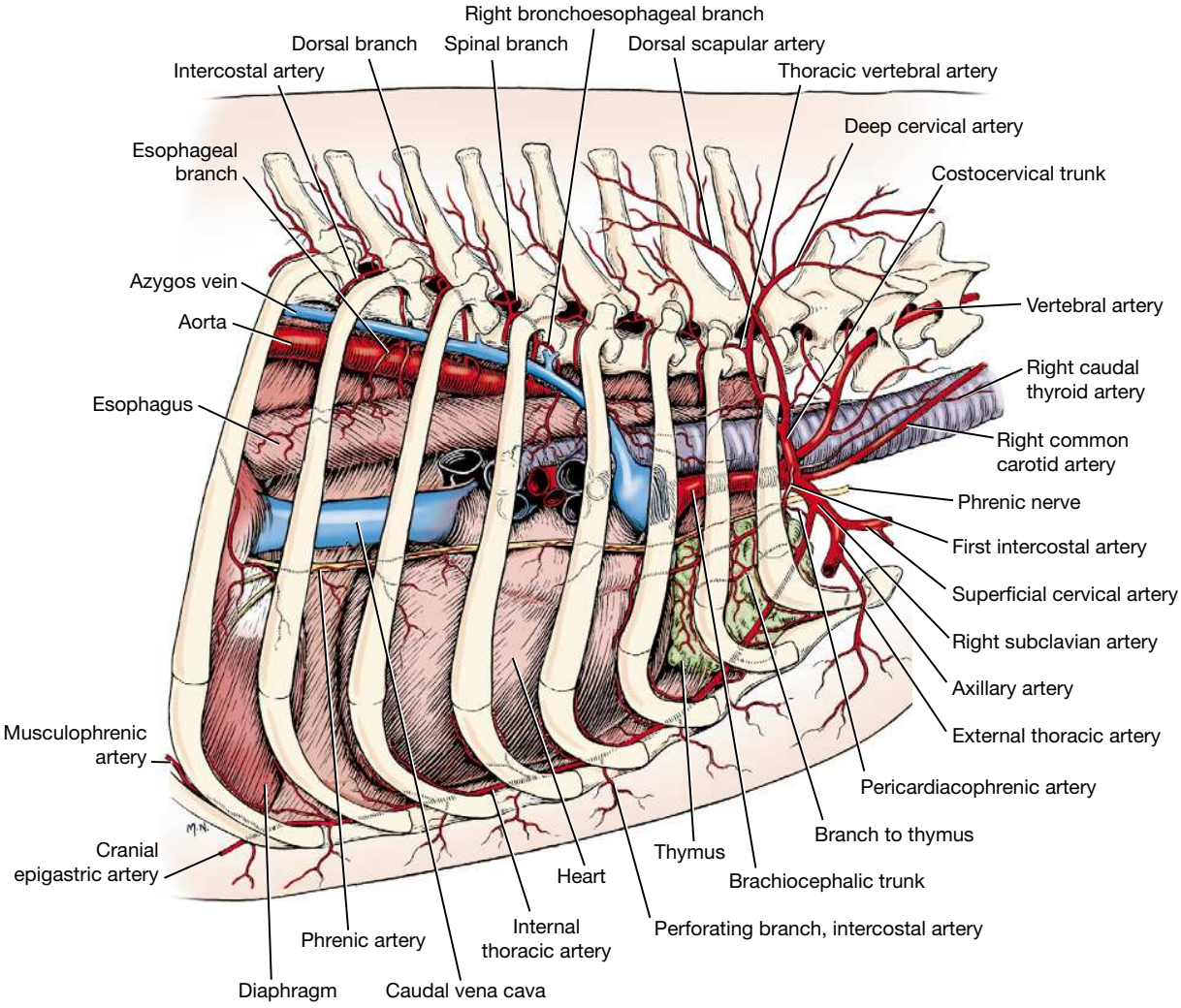


Fig. 3-14 Arteries of thorax, right lateral view.

visible.) Here it crosses the ventral surface of the fifth thoracic vertebra and courses on the left side of the middle mediastinal pleura. It continues cranioventrally through the cranial mediastinum to the left brachiocephalic vein, where it usually terminates (Fig. 3-17). The thoracic duct also receives the lymph drainage from the left thoracic limb and the **left tracheal trunk** (from the left side of the head and neck). The lymph drainage from the right thoracic limb and the **right tracheal trunk** (from the right side of the head and neck) form a right lymphatic duct that enters the venous system in the vicinity of the right brachiocephalic vein. There are often multiple terminations of a complicated nature, which may include swellings or anastomoses. All lymphatic channels will be difficult to see unless they are congested with lymph or refluxed blood. They are frequently double.

Look for the thoracic duct. It is not always visible, but it may be identified by the reddish brown or straw color of its contents and the numerous random constrictions in its wall. The tracheal trunks may be found in each carotid sheath or parallel to the sheath and its contents.

Arteries Cranial to the Heart

The **aorta** (Figs. 3-8, 3-9, 3-14, 3-16, 3-17, 3-20) is the large, unpaired vessel that emerges from the left ventricle medial to the pulmonary trunk. As the **ascending aorta,** it extends cranially, covered by the pericardium; it makes a sharp bend dorsally and to the left as the **aortic arch**; it runs caudally as the **descending aorta** located ventral to the vertebrae. The part cranial to the diaphragm is the thoracic aorta, and the caudal part is the abdominal aorta. Cranial to the heart are several branches of

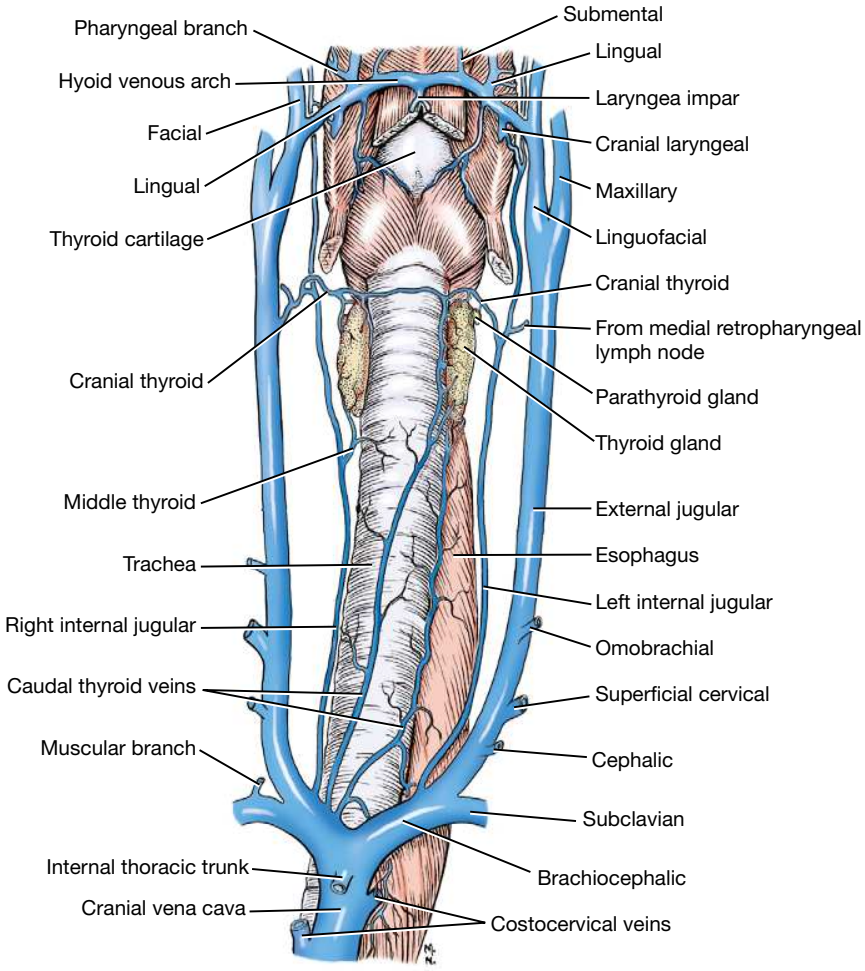


Fig. 3-15 Veins of the neck, ventral aspect.

the aorta. Reflect the veins that were dissected cranial to the heart to observe these arteries.

The right and left **coronary arteries** are branches of the ascending aorta that supply the heart muscle. They will be studied with the heart.

The **brachiocephalic trunk** (Figs. 3-14, 3-16 through 3-20), the first branch from the aortic arch, passes obliquely to the right across the ventral surface of the trachea. It gives rise to the **left common carotid artery** and terminates as the **right common carotid artery** and the **right subclavian artery**.

The **left subclavian artery** (Figs. 3-16 through 3-20) originates from the aortic arch beyond the level of the brachiocephalic trunk and passes obliquely to the left across the ventral surface of the esophagus.

The branches of the right and left subclavian arteries are similar; only the right subclavian artery will be described. For each artery described, there is a comparable vein with a similar area of distribution. The terminations of the veins are variable, and they will not be dissected. Remove them when necessary to expose the arteries. The right subclavian artery has four branches that arise medial to the first rib or intercostal space. They are the vertebral artery, the costocervical trunk, the superficial cervical artery, and the internal thoracic artery. Do not sever the nerves or arteries.

The **vertebral artery** (Figs. 3-14, 3-16 through 3-20) crosses the medial surface of the first rib and disappears dorsally between the longus colli and the scalenus muscles. It enters the transverse foramen of the sixth cervical vertebra and passes through the transverse foramina of the first six cervical vertebrae. It supplies both muscular branches to the cervical muscles and also spinal branches at each intervertebral foramen to the spinal cord and its coverings. At the level of the atlas, it terminates by entering the vertebral canal through the lateral vertebral foramen and contributes to the ventral spinal and basilar arteries. These will be seen later in the dissection of the nervous system.

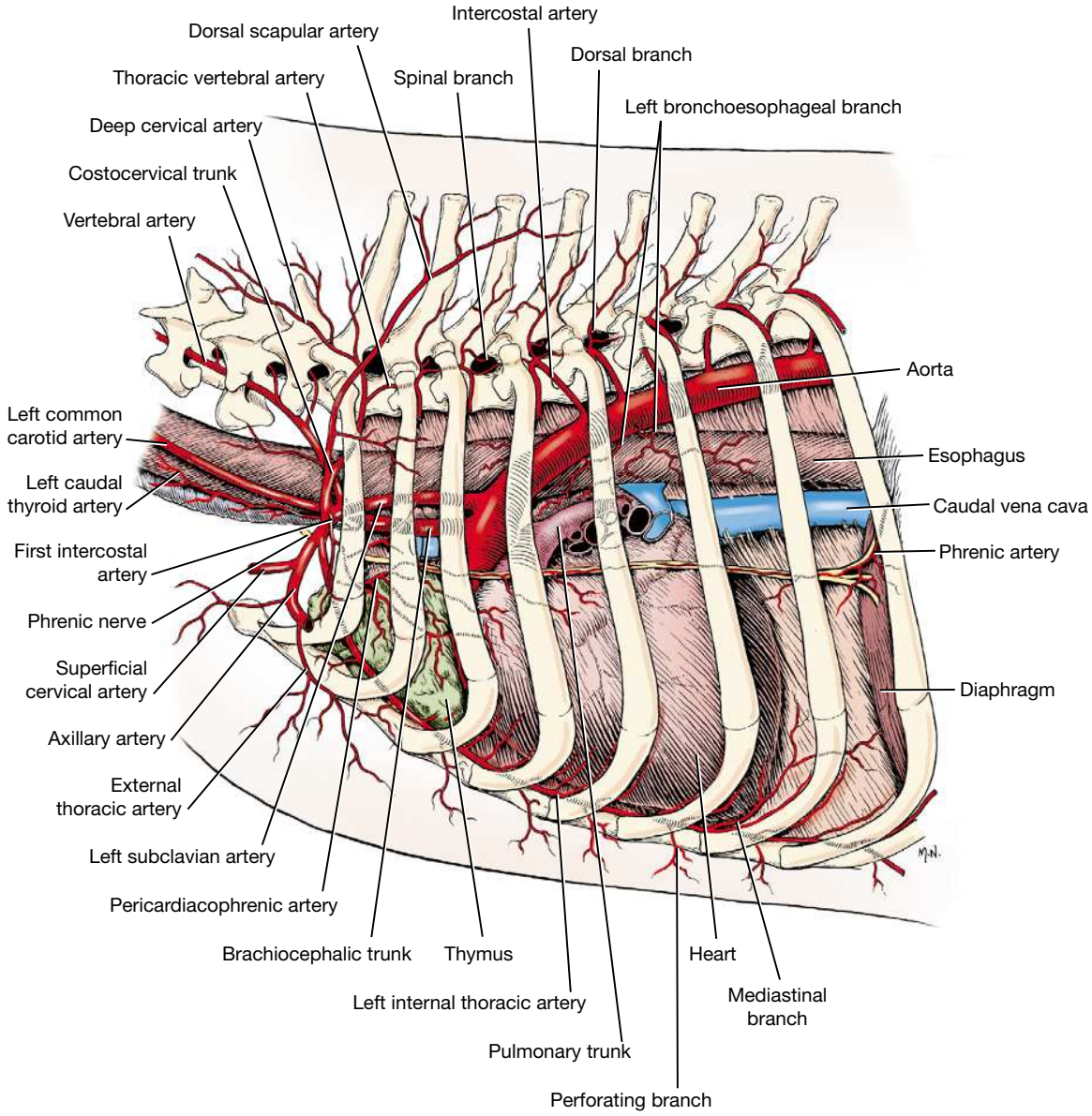


Fig. 3-16 Arteries of thorax, left lateral view.

The **costocervical trunk** (Figs. 3-14, 3-16 through 3-20) arises distal to the vertebral artery, crosses its lateral side, and extends dorsally as far as the vertebral end of the first rib. By its various branches it supplies the structures of the first, second, and third intercostal spaces; the muscles at the base of the neck; and the muscles dorsal to the first few thoracic vertebrae. These need not be dissected.

The **superficial cervical artery** (Figs. 3-14, 3-16 through 3-20, 3-26) arises from the subclavian opposite the origin of the **internal thoracic artery**, medial to the first rib. It emerges from the thoracic inlet to supply the base of the neck and the adjacent scapular region.

Branches of the Thoracic Aorta

The **esophageal** and **bronchial arteries** vary in number and origin. Usually the small **bronchoesophageal artery** (Figs. 3-14, 3-16) leaves the right fifth intercostal artery close to its origin and crosses the left face of the esophagus, which it supplies. It terminates shortly afterward in the **bronchial arteries**, which supply the lung.

There are eight to nine pairs of **dorsal intercostal arteries** that leave the aorta (Figs. 3-4, 3-5, 3-16, 3-19, 3-20). These start with either the fourth or the fifth intercostal artery and continue caudally, there being an artery in each of the remaining intercostal

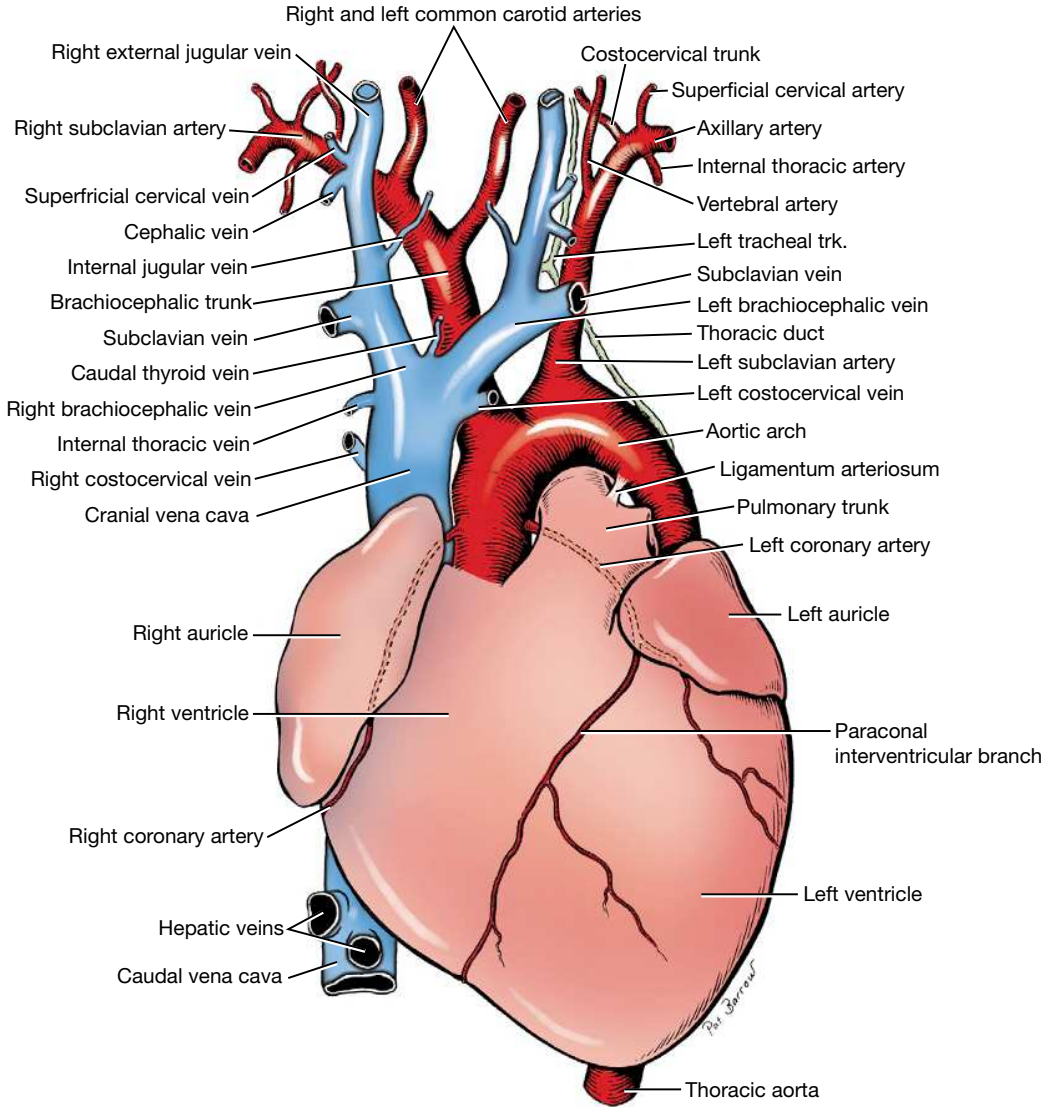


Fig. 3-17 Heart and great vessels, ventral view.

spaces. Each lies close to the caudal border of the rib. The costocervical trunk supplies the first three or four intercostal spaces (Fig. 3-19). The dorsal costoabdominal artery courses ventrally, caudal to the last rib.

The **phrenic nerves** (Figs. 3-14, 3-16, 3-20) supply the diaphragm. Find each nerve as it passes through the thoracic inlet. The nerve arises from the ventral branches of the fifth, the sixth, and usually the seventh cervical nerves. Follow the phrenic nerves through the mediastinum to the diaphragm. Each is both motor and sensory to the corresponding half of the diaphragm except at its periphery. This part of the muscle receives sensory fibers from the caudal intercostal nerves.

INTRODUCTION TO THE AUTONOMIC NERVOUS SYSTEM

The **nervous system** is highly organized both anatomically and functionally. It is composed of a **central nervous system** and a **peripheral nervous system**. The central nervous system includes the **brain** and the **spinal cord**. The peripheral nervous system comprises the **cranial nerves,** which connect with structures of the head and body, and the **spinal nerves**, which connect the spinal cord to structures of the neck, trunk, tail, and limbs. The peripheral nervous system can be further classified on the basis of anatomy and function. The peripheral nerves contain axons that conduct impulses *to* the central nervous system—**sensory, afferent**

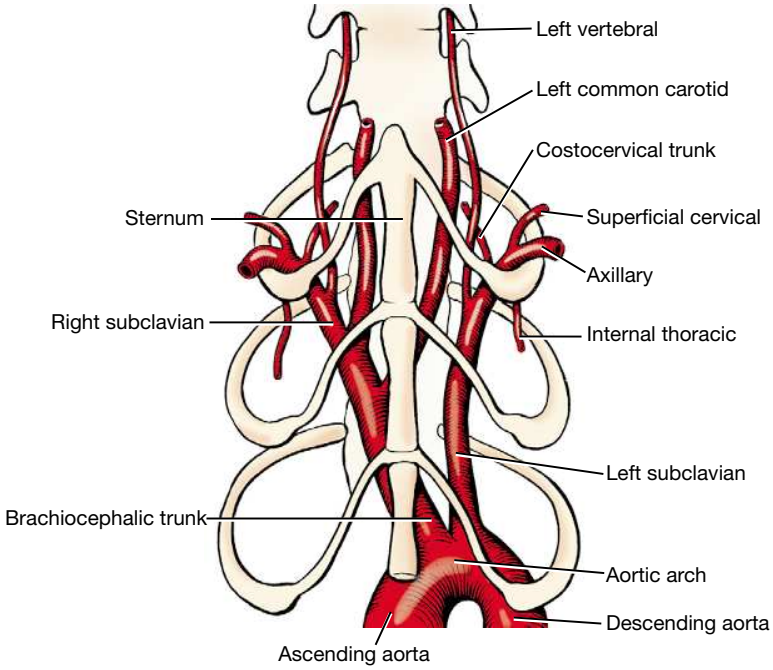


Fig. 3-18 Branches of aortic arch, ventral view.

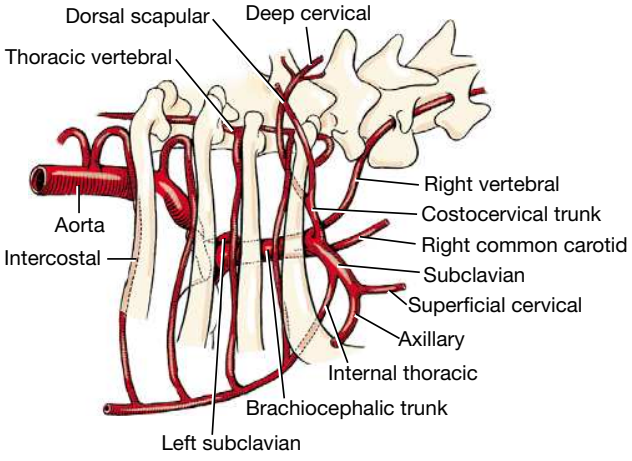


Fig. 3-19 Branches of brachiocephalic trunk, right lateral view.

axons—and axons that conduct impulses *from* the central nervous system to muscles and glands of the body—**motor, efferent axons**. Most peripheral nerves have both sensory and motor axons. When one speaks of a motor nerve, it is an indication of the primary function of the majority of the neurons, but it is understood that sensory neurons are also present. Likewise, so-called sensory nerves also contain motor neurons. This duality is the basis of feedback regulation. All the nerves you dissect are bundles of neuronal processes belonging to both sensory and motor neurons.

The **motor portion** of the peripheral nervous system is classified according to the type of tissue being innervated. Motor neurons supplying voluntary, striated, skeletal muscle are **somatic efferent neurons**. *Somatic* refers to the body, body wall, or head, neck, trunk, and limbs where these striated skeletal muscles are located. Those supplying involuntary, smooth muscle of viscera, blood vessels, cardiac muscle, and glands are **visceral efferent neurons**.

A **neuron** is composed of a cell body and its processes. A somatic motor neuron of the peripheral nervous system has its cell body located in the gray matter of the spinal cord or brain stem, and its process, or axon, courses through the peripheral spinal or cranial nerve to end in the muscle innervated. Thus there is only one neuron spanning the distance from the central nervous system to the innervated structure.

The autonomic nervous system consists of components of the peripheral and central nervous systems. Its function is to control involuntary activity, to maintain homeostasis, and to respond to stress. The visceral efferent system is the peripheral motor part of this **autonomic nervous system**. It differs anatomically from the somatic efferent system in having a second motor neuron interposed between the central nervous system and the innervated structures. One neuron has its

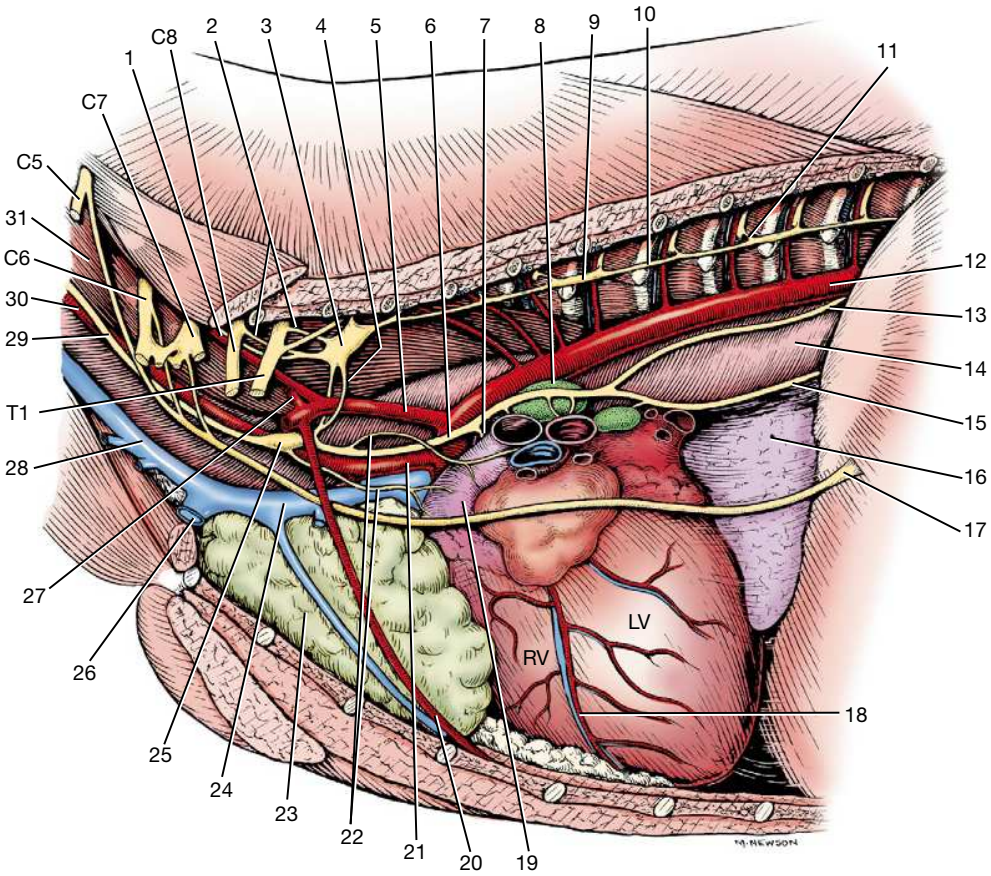


Fig. 3-20 Thoracic autonomic nerves, left lateral view, lung removed.

1. Vertebral artery and nerve
2. Communicating rami from cervicothoracic ganglion to ventral branches of cervical and thoracic nerves
3. Left cervicothoracic ganglion
4. Ansa subclavia
5. Left subclavian artery
6. Left vagus nerve
7. Left recurrent laryngeal nerve
8. Left tracheobronchial lymph node
9. Sympathetic trunk ganglion
10. Sympathetic trunk
11. Ramus communicans
12. Aorta
13. Dorsal branch of vagus nerve
14. Esophagus
15. Ventral trunk of vagus nerve
16. Accessory lobe of lung (through caudal mediastinum)
17. Phrenic nerve to diaphragm
18. Paraconal interventricular a., v., and groove
19. Pulmonary trunk
20. Internal thoracic artery and vein
21. Brachiocephalic trunk
22. Cardiac autonomic nerves
23. Thymus
24. Cranial vena cava
25. Middle cervical ganglion
26. Left subclavian vein
27. Costocervical trunk
28. External jugular vein
29. Vagosympathetic trunk
30. Common carotid artery
31. Longus colli muscle

cell body located in the gray matter of the central nervous system. Its axon courses in the peripheral nerves only part of the way toward the structure to be innervated. Along the course of the peripheral nerve is a gross enlargement called a **ganglion**. By definition, a ganglion is a collection of neuronal cell bodies located outside the central nervous system. Some ganglia have a motor function, others a sensory function. Groups of neuronal cell bodies within the central nervous system are called **nuclei**. Autonomic ganglia contain the cell bodies of the second motor neurons in the pathway of the visceral efferent system. Their axons complete the pathway to the structure being innervated. Because of its relationship to the cell bodies in the autonomic ganglia, the first visceral efferent neuron with its cell body in the central nervous system is called the **preganglionic neuron**. The cell body of the second neuron is in an autonomic ganglion. Its axon is **postganglionic**.