THE RESPIRATORY SYSTEM

The organs of the *respiratory system* are studied by examining the ventral *neck region* and the *thoracic cavity*.

The Dissection

Begin your dissection of the thoracic cavity by making an incision with your scissors at the mid-ventral base of the rib cage. Follow incision No. 4 as shown in the photo, page 85. Continue your incision until the top rib has been cut. Then cut laterally as incision No. 5. Separate the edges of the *diaphragm* from the ventral and lateral walls of the thorax. You are now ready to spread the rib cage and expose the *heart* and *lungs*.

Next, cut laterally along the mid-ventral line into the musculature of the neck toward the chin. Separate the neck muscles to expose the *trachea*, *larynx*, *thyroid gland*, *jugular veins*, and *carotid arteries*, as in the accompanying photo (page 94).

Note the following:

The *nasal passages*, *pharynx*, and *nasopharynx* were studied when the oral cavity was considered. (See page 76.)

PLEURA — This is the serous membrane found within the thorax. The *parietal pleura* lines the inner walls while the *visceral pleura* covers the organs of the thorax. The *pleura* corresponds to the *peritoneum* of the abdominal cavity.

DIAPHRAGM — This muscular wall, separating the thoracic from the abdominal cavities, is also an important organ of respiration. Its movements fill and empty the lungs of air.

TRACHEA — The *trachea*, or windpipe, is a prominent banded tube which extends along the mid-ventral portion of the neck into the thoracic cavity. Here it branches to form the *bronchi*, which penetrate the lungs. The trachea and bronchi are always kept open by cartilage rings along their entire lengths. They give support and shape to the cylindrical walls of the trachea, and maintain an open air passage.

The Dissection

Remove a half-inch section of the trachea and examine its structure. Cut it lengthwise across the rings. Note that the cartilage rings are incomplete dorsally, thus forming the letter "C." Is there an advantage to this? Hint: note the position of the *esophagus* in relation to the trachea. What would be the effect of peristalsis upon the trachea if the rings were complete?

LARYNX — This structure, also known as the *voice box*, is located at the top of the trachea. Its uppermost segment is the *epiglottis*, which articulates with the *hyoid bone* anteriorly. The larynx is composed of several cartilaginous elements, which may best be distinguished by the use of a dissection microscope. These include the:

Epiglottis — The cone-shaped flap of cartilage that protects the *glottis*, the opening to the *trachea*.

Thyroid Cartilage — This is ventral, large, and shield-shaped.

Cricoid Cartilage — This is a complete ring of cartilage on the posterior end of the larynx.

Arytenoid Cartilage — This cartilage is paired, small, pyramid-shaped; it is located dorsally at the anterior border of the *cricoid cartilage*.

The Dissection

With your scalpel, cut into the larynx, along the mid-ventral line, and separate the right from the left side. Examine the inner surface. Locate the *vocal folds*, or *vocal cords*, two shelf-like membranes supported by elastic ligaments that extend from the *arytenoid cartilages* to the *thyroid cartilage*.

LUNGS — Examine the lungs on either side of the *heart*. They feel more spongy in freshly killed specimens and more rubbery in preserved specimens.

The right lung has four lobes: *anterior, middle, posterior,* and the *post caval*. The last lobe is not as readily visible as the other three. It lies deep medially, in contact with the diaphragm and the apex of the heart. The left lung has only one lobe. In humans the right lung has three lobes and the left lung has two. Each lung lies within a separate *pleural cavity*, the space between the lung and the thoracic body wall. The lungs, as well as the inner thoracic body wall, are covered by the *pleura*, a fine transparent membrane.

The *bronchi* branch repeatedly to form *bronchioles* within the lung tissue. These terminate as the microscopic *alveoli*, or air sacs. The exchange of gases between the lungs and the bloodstream takes place across the walls of the alveoli. Cartilage rings reinforce the larger bronchioles, but are absent in the narrower branches and in the alveoli.

The Dissection

Remove a small, thin section of lung and observe with a hand lens or low power dissection microscope. Your specimen has been doubly injected (arteries and veins); thus, you should observe three types of vessels within the lung tissue:

1. **Pulmonary Artery** — Branches of this vessel contain *blue* dye.

2. **Pulmonary Veins** — Branches of these vessels contain *red* dye.

Note: The colors of the pulmonary artery and veins are the reverse of those of the other parts of the body.

3. **Bronchioles** — These branches of the *bronchi*, distributed throughout the lungs, are hollow, with *white* edged walls.

Try to float a section of lung in a beaker of water. Does it float or sink? Explain.

Other structures seen during this dissection which are not parts of the respiratory system are listed below. Several of these will be studied when the circulatory system is considered.

PERICARDIUM—This fibrous, double-layered membranous sac encloses the heart and the larger blood vessels at the anterior end of the heart.

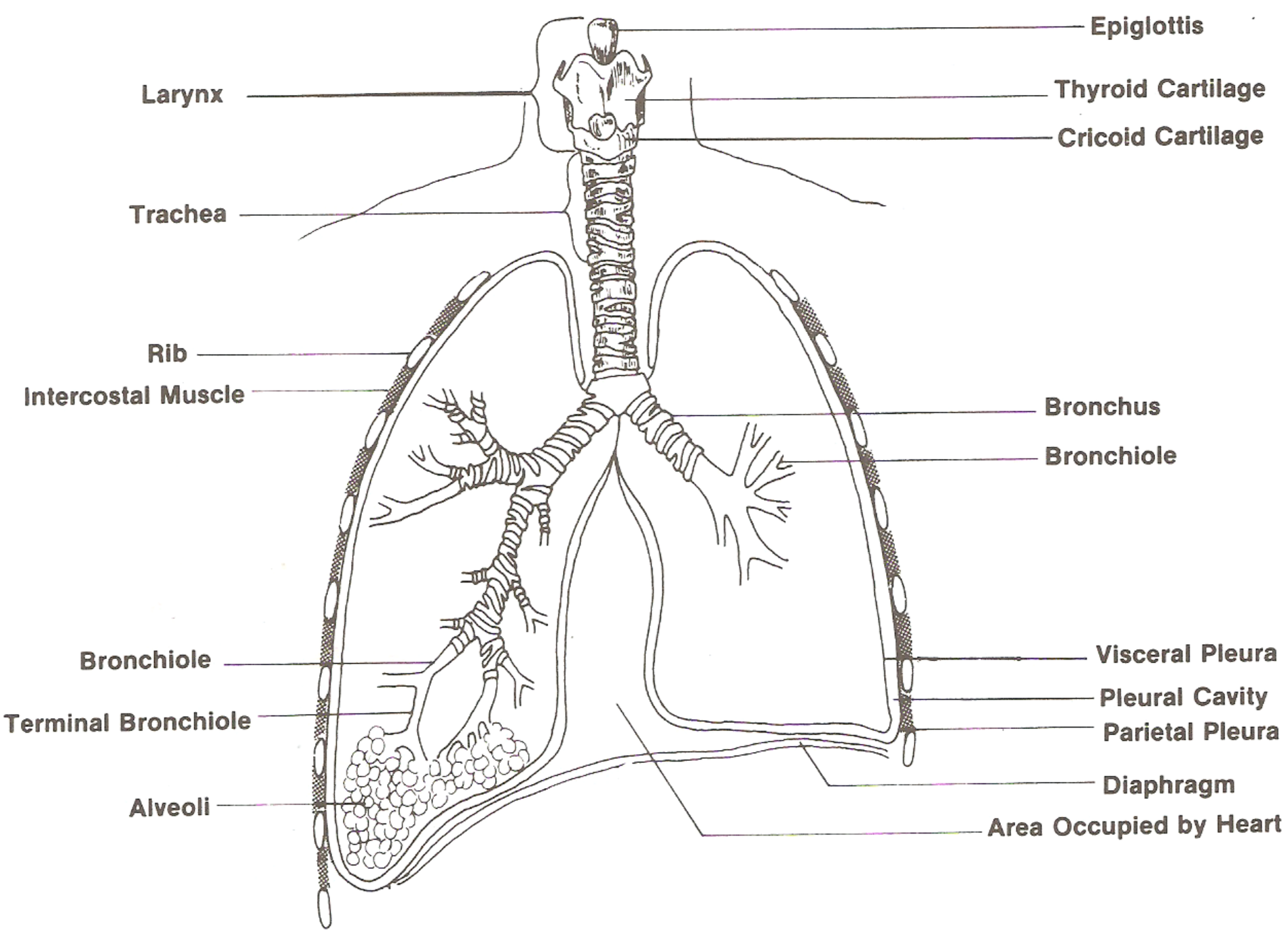
HEART—This conical organ is located in the center of the thorax, within the *mediastinum*, the space between the lungs. It will be studied more thoroughly in the next chapter.

LARGE BLOOD VESSELS—These include the *aortic arch* and its branches, the *pulmonary artery*, the two *anterior venae cavae*, and a single *posterior vena cava*.

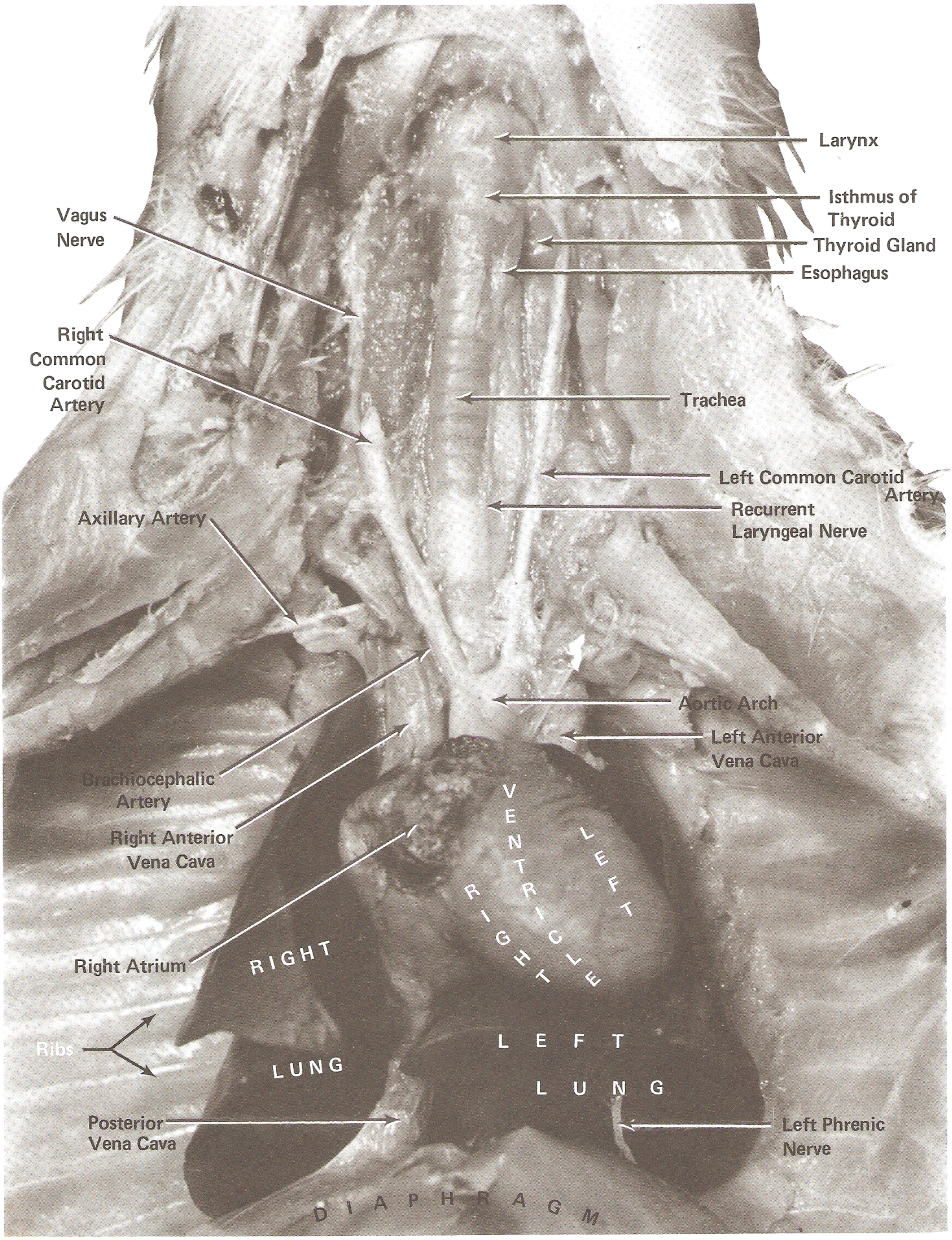
ESOPHAGUS—The food pipe, or *esophagus*, lies dorsal to the *trachea* and extends through the thorax along the left side. It has already been studied in the unit on the digestive system. Move the left lung toward the mid-line and examine the muscular esophagus below. Do not mistake it for the thoracic *aorta*, which lies along the dorsal mid-line. The esophagus passes through the diaphragm into the abdominal cavity to join the *stomach*.

THYROID GLAND—This gland is composed of two lobes, which lie on either side of the *trachea*, at the base of the *larynx*. A connecting segment between the two lobes, the *isthmus*, is found on the ventral surface of the cricoid cartilage. The thyroid hormones, *thyroxine* and *triiodothyronine*, regulate the body's rate of metabolism. Small *parathyroid glands* are embedded in the extreme latero-dorsal portions of each lobe. Their hormones regulate the body's calcium and phosphorus metabolism.

THYMUS GLAND—This gland is relatively large in younger animals and becomes smaller as the animal matures. In young animals it may occupy much of the space ventrally from the larynx to the heart. In the adult rat the two *lobes* of this gland lie between the two *anterior venae cavae*, covering the *trachea* at its bifurcation. It functions as a part of the lymphatic system and in establishing the immune response in animals.



THE HUMAN RESPIRATORY TRACT


Larynx
Isthmus of Thyroid
Thyroid Gland
Esophagus
Vagus Nerve
Right Common Carotid Artery
Trachea
Left Common Carotid Artery
Recurrent Laryngeal Nerve
Axillary Artery
Aortic Arch
Left Anterior Vena Cava
Brachiocephalic Artery
Right Anterior Vena Cava
VENTRICLE
RIGHT
LEFT
Right Atrium
RIGHT
LUNG
Ribs
LEFT
LUNG
Posterior Vena Cava
Left Phrenic Nerve
DIAPHRAGM

THE CIRCULATORY SYSTEM

The function of the circulatory system is the *transport* of materials to and from the cells of the body. The organs of multicellular animals are too far removed from the external environment to enable them to exchange nutrients, oxygen, and wastes directly by diffusion. Instead, the materials needed by cells must be brought to them by a circulatory system, and the cellular wastes must similarly be removed.

The structures comprising the circulatory system include the:
— heart
— arteries and arterioles, usually injected with *red* latex dye
— capillaries
— veins and venules, usually injected with *blue* latex dye
— blood, the circulating medium of transport.

THE HEART

The Dissection

The thorax has already been opened, and you have noted some of the organs and structures of the circulatory system when studying the respiratory system. These included the *pericardium, heart,* and some of the large blood vessels entering and leaving the heart.

Grasp the *pericardium* with your forceps and begin to cut it with your scissors. Remove the entire *pericardial sac*. Free it from its connection to the large blood vessels anteriorly. Expose the entire *heart*.

The heart of mammals consists of four chambers, two *atria* and two *ventricles*. Examine the heart, looking for all of the structures mentioned below.

ATRIA — The atria are ear-like sacs (auricles) on the right and left sides of the anterior portion of the heart. They receive blood from the entire body.

Right Atrium — Lift up the heart to examine its dorsal surface. You will see two large blue vessels, the *right* and *left anterior venae cavae*, entering the *right atrium* from above the heart, and one large blue vessel, the *posterior cava*, entering from below. Note that dorsal to the heart, the left anterior vena cava turns sharply to the right just before entering the right atrium. Deoxygenated blood from all parts of the body enters the heart here.

Left Atrium — This chamber receives oxygenated blood from the lungs by way of four small *pulmonary veins*. They lie deeply and are generally not injected, thus difficult to find.

VENTRICLES — These are the much larger and much more muscular chambers on the posterior portion of the heart. Externally, one cannot clearly identify the limits of the right and left ventricles. They exert the force that pumps the blood to all parts of the body.

Right Ventricle — This chamber pumps deoxygenated blood to the *lungs* by way of the pulmonary artery.

Left Ventricle — This chamber pumps oxygenated blood to the entire body. Its major vessel is the wide *aorta*.

The Dissection

Cut the heart transversely, as in the photograph on page 109. Remove any coagulated blood or dye. Note the differences between the "half-moon shaped" right ventricle and the round left ventricle. Which has thicker walls? How does this relate to its function? Note the muscular wall, the *interventricular septum*, separating the ventricles. Observe small mounds of muscle, the *papillary muscles*, with tough tendinous cords known as the *chordae tendinae* attached. These are, in turn, attached anteriorly to the flaps of the *atrio-ventricular valves*: the *tricuspid valve*, on the right and *bicuspid*, or *mitral valve*, on the left, and prevent the valves from turning inside-out during the ventricles' contractions.

Locate the origins of the *pulmonary artery* and the *aorta* within the ventricles. It will be necessary to cut further anteriorly into the wall of the ventricle. The entrance to each is guarded by a *semilunar valve*, the *pulmonary and aortic semilunars*.

Coronary Vessels

Upon the surface of the heart note branching blood vessels. These are the *coronary arteries* and *veins*. They distribute blood to and drain the *myocardium*, the muscular wall of the heart. The coronary arteries are the first branches of the aorta directly anterior to the aortic semilunar valve, before the aorta has left the ventricle. The coronary veins drain into the *right atrium* by way of the *coronary sinus*.

THE VEINS

We shall begin our study of the blood vessels with the veins, the vessels that transport blood *to* the heart, since they lie closer to the surface than the arteries. It should be pointed out, however, that many veins and arteries travel together and are named identically.

Veins are much thinner-walled than arteries. Thus, they are more easily damaged and greater care is required during dissection. In addition, due to the valves in the veins, the injected blue dye may not have passed to the minor vessels. Therefore many veins will appear as thin tubes filled with a clear fluid, the preservative.

Venae Cavae

As was already noted in our study of the rat's heart, three venae cavae drain the body's deoxygenated blood and enter the heart. In humans, and in most higher mammals, there are only two venae cavae, one above the heart and one below.

RIGHT ANTERIOR VENA CAVA and **LEFT ANTERIOR VENA CAVA** — These join at the heart and enter as a single vessel into the *right atrium*. The *right anterior vena cava* drains the head, shoulder, and forelimb on the right side. The *left anterior vena cava* drains the left side. The venous branches entering the anterior venae cavae from the right and left are identical. They are bilaterally symmetrical.

POSTERIOR VENA CAVA — This single vein drains deoxygenated blood from the entire body below the heart. It too enters the *right atrium*. It is formed within the posterior abdominal cavity as a union of

two veins which bring blood from the lower extremities. It comes to lie along the dorsal mid-line, to the right of the *abdominal aorta*.

We shall first study the veins above the heart, which drain into the *anterior venae cavae*, and then those below the heart, which drain into the *inferior vena cava*.

Anterior Veins

All except one of the veins draining into the anterior venae cavae are paired. Those from the right side enter the right anterior vena cava, and those from the left side enter the left anterior vena cava.

The Dissection

Trace the veins with your *needle probe*. Work carefully, as the thin-walled veins are easily injured or destroyed. Trace each vessel as far as you can. Some of the peripheral veins may not be injected. This makes it harder to trace their origins. Do not destroy the arteries you come across. Identify the following veins:

AZYGOUS VEIN — This anterior vein is not paired in the rat. It is found on the *left* side only. To see this vein, deflect the left lung and the heart to the right. The *azygous* vein lies to the left of the vertebral column and the dorsal thoracic aorta. It drains the *intercostal veins* of both the left and right sides. It continues anteriorly to enter the left anterior vena cava just before it enters the right atrium. In some specimens a *hemiazygous* vein, which joins the azygous vein, will be found on the right side.

INTERNAL THORACIC (INTERNAL MAMMARY) VEIN — This narrow paired vessel receives blood from the ventral wall of the thorax. It may have been destroyed in your dissection of the thorax.

SUBCLAVIAN VEIN — This major vein receives blood from the head, the thoracic wall, and the forelimb. As its name implies, it lies under the *clavicle*.

Axillary Vein — This vein is the continuation of the *subclavian* that receives blood from the forelimb. It lies in the area of the *armpit* (axilla).

Lateral Thoracic Vein — This vein brings blood to the *axillary* vein from the lateral walls of the thorax.

Brachial Vein — This is a further continuation of the axillary vein into the forelimb. It brings blood from the inner elbow anteriorly. It accompanies the brachial artery and median nerve.

Median Vein — This vein drains some of the blood of the front paws, then runs between the ulna and the radius to empty into the *brachial vein*.

INTERNAL JUGULAR VEIN — This vein is much narrower than the *external jugular* and relatively smaller than in man. As its name indicates, it lies medial to the external jugular. It receives smaller veins from the larynx, thyroid, and trachea. It originates in the *venous sinuses* of the brain and leaves the skull in the occipital region. At the base of the neck it unites with the *subclavian vein* to form the *anterior vena cava*.

EXTERNAL JUGULAR VEIN — This much longer and thicker vein lies lateral to the *internal jugular vein*. It receives blood from the face and jaws anteriorly and from the forelimb posteriorly. At its base it joins the *axillary vein* to form the *subclavian vein*. Some of the veins which drain into the external jugular vein are:

Omocervical (Accessory Cephalic) Vein — This vein drains the superficial muscles in the upper thorax and shoulder regions. It fuses with the cephalic vein in the region of the deltoid muscle.

Cephalic Vein — This vein passes over the anterior portion of the shoulder and proceeds to the distal portion of the forelimb along the radial or "thumb" side. It may be seen superficially on the lateral surface of the forelimb.

Median Cubital Vein — This vein crosses the inside of the elbow to join the *median* to the *cephalic vein*, thus draining both.

Linguofacial (Anterior Facial) Vein — Near its anterior end, the *external jugular vein* is seen to result from the juncture of two facial veins. One is the *linguofacial vein* medially. It drains the tongue, salivary glands, lower jaw, and anterior parts of the face.

Maxillary (Posterior Facial) Vein — This is the more lateral tributary leading into the external jugular vein. It drains the chewing muscles, ear, and eye, as well as the more dorsal and posterior parts of the head and face.

Posterior Veins

All of the veins below the heart transport blood anteriorly. They all enter the large *posterior vena cava*, which joins the right atrium of the *heart*.

The Dissection

Since the abdominal cavity has already been opened, further dissection is not necessary at this time. Simply deflect the left abdominal viscera to the right, clearing the mid-dorsal region in order to observe the vena cava and the veins leading into it. Use your needle probe to clear connective tissue, fat, and smaller muscle masses.

Find the following veins:

HEPATIC VEINS — These veins enter the vena cava as it passes through the liver.

PHRENIC VEINS — These are small veins which drain the diaphragm.

RENAL VEINS — These thick veins project medially from the center of the kidneys to join the vena cava.

Adrenal Veins — These paired veins from the *adrenal glands* join the *renal vein*.

Left Gonadal Vein (*Spermatic* in males, *Ovarian* in females) — Only the left gonad drains into the *renal vein*; the right gonad transports its blood directly into the posterior vena cava.

Right Gonadal (Spermatic or **Ovarian) Vein** — This vein can be located entering the vena cava on the same level as the *renal vein*.

ILIOLUMBAR VEIN — Follow the posterior vena cava below the kidneys. Find the paired iliolumbar veins extending laterally from the vena cava. They collect blood from the dorsal and lateral musculature and from fat deposits in this region.

COMMON ILIAC VEIN — The *posterior vena cava* is formed within the posterior abdominal cavity as a union of two veins which bring blood from the lower extremities. These are the *common iliac veins*, one entering the abdominal cavity from the right side, the other from the left. Together with the posterior vena cava they assume the shape of an inverted "Y."

Each common iliac vein is formed by the junction of two other veins, the *internal iliac (medial femoral circumflex)* and the *external iliac*.

Internal Iliac (Medial Femoral Circumflex) Vein — This vein originates from the medial pelvis and thus drains the veins of the reproductive and urinary organs, the gluteal area, and the deeper muscles of the pelvis. The names of some of these veins are: *vesicular, obturator, pudendal*, and *gluteal*.

External Iliac Vein — This vein passes more laterally to receive blood from the hind leg. It also has tributaries from the pelvic area.

Femoral Vein — This vein is the main continuation of the *external iliac vein* to the leg. It lies upon the medial surface of the thigh together with the femoral artery. It receives blood from the deeper and superficial muscles as well.

Popliteal Vein — This is a continuation of the *femoral vein* in the area behind the knee and lateral to it.

Anterior and Posterior Tibial — These two veins drain the lower shank and foot area. They join to form the *popliteal vein*.

Saphenous Veins — The *great* and *small saphenous veins* are located just below the surface of the skin of the hind limb. They drain the superficial as well as some of the deeper musculature. The great saphenous joins the *femoral vein*, while the small saphenous is drained by the *popliteal vein*.

Plantar Veins — These are a series of four veins in the metatarsal area of the paw. They join to form the *plantar venous arch*. Proximally these veins are drained by the *great saphenous vein*.

The Hepatic Portal System

This system of veins is unlike the venous systems of the rest of the body. The veins from most of the abdominal viscera do not join the posterior vena cava directly. Instead, blood from the stomach, spleen, small intestine, and large intestine drain into a large vein known as the *hepatic portal vein*, which enters the *liver* and there breaks up into capillaries called *sinusoids*. The hepatic portal vein is rich in digested nutrients that have been absorbed across the wall of the small intestine. Before these enter the general circulation, the liver transforms them according to the needs of the body by a process known as *intermediary metabolism*. Glucose may be stored as glycogen, amino acids deaminated, or fatty acids converted to carbohydrates.

From the liver, blood returns via the *hepatic veins* into the inferior vena cava. Thus, in an indirect way, by way of the liver, blood from the abdominal viscera is once again returned to the general circulation.

The Dissection

In order to expose the hepatic portal vessels, move the stomach, spleen, pancreas, small intestine, and large intestine to the left. In triply injected specimens this system of veins will be yellow; in doubly injected ones it will be poorly injected, if at all.

HEPATIC PORTAL VEIN

Three major veins unite to form the *hepatic portal vein*. These are discussed below.

1. **SPLENIC (LIENAL) VEIN** — This vein originates in the spleen. It receives blood from the following tributaries:

   Pancreatic Vein — from the pancreas

   Left Gastroepiploic Vein — from the greater curvature of the stomach

   Coronary Vein — from the lesser curvature and cardiac portion of the stomach.

2. **SUPERIOR MESENTERIC VEIN** — This vein receives the following tributaries:

Middle Colic Vein — from the rectum and distal part of the colon

Posterior Mesenteric Vein — from the descending colon and rectum

Right Colic Vein — from the ascending colon

Ileocolic Vein — from the first part of the colon

Intestinal Veins — a series of about 16 branches from the ileum and jejunum

Posterior Pancreaticoduodenal Vein — from the head of the pancreas and the distal portion of the duodenum.

3. **PYLORIC VEIN** — This vein originates from the pyloric region of the stomach. It enters the hepatic portal vein a short distance above the splenic vein, just below the liver. It is joined by the:

Anterior Pancreaticoduodenal Vein — from the pancreas and duodenum.

THE ARTERIES

Anterior Arteries

The Dissection

Return to the *heart* and remove the major veins surrounding it. This will enable you to expose the *arteries*. Make use of your dissecting needles and probes to clear arteries of connective tissue, to separate them, and to trace them to the organs that they nourish.

Arteries are blood vessels that transport blood *away from* the heart. Their walls are much thicker than those of veins with similar outside diameters. As a result, arteries are generally better injected than veins. Thus, even smaller arteries will appear colored red.

We shall begin with the large arteries leaving the heart and trace them anteriorly. Then we shall study the arteries below the heart.

PULMONARY ARTERY

This large artery exits the *right ventricle*. It may be seen on the ventral side of the heart passing anteriorly and dorsally toward the left. It soon branches to the right and left *lungs*. Trace the two branches. In doubly or triply injected specimens, the pulmonary is the only artery injected with blue latex dye to indicate that it carries deoxygenated blood. All other arteries will appear red because they have been injected with red latex dye to indicate that the blood transported within them is oxygenated.

AORTA

Locate the aorta, the largest systemic artery in the body. It leaves the *left ventricle* of the heart, passes anteriorly, curves to the left, dorsal to the pulmonary artery, and continues dorsally in a posterior direction along the left side of the vertebral column.

The proximal portion of this artery is known as the *ascending aorta* and the curved portion is the *aortic arch*. It then descends along the mid-dorsal line within the thorax. It is then known as the *thoracic aorta*. Below the diaphragm it becomes the *abdominal aorta*.

Near its origin, within the heart itself, the ascending aorta give off two branches, the *right* and *left coronary arteries*. These may be seen on the ventral surface of the ventricles, sending branches deep into the myocardium, supplying the heart muscle with necessary nutrients and oxygen.

The aortic arch gives rise to arteries that supply the neck, head, shoulders, and forelimbs of the rat. As in man, three arterial trunks arise from the aortic arch. These are the *brachiocephalic (innominate), left common carotid*, and *left subclavian arteries*.

1. BRACHIOCEPHALIC (INNOMINATE) ARTERY — As its name indicates, this artery supplies blood to the forelimbs and the head. It is a wide vessel that branches off to the right side of the *aortic arch* and passes anteriorly to the level of the clavicle, where it divides to form two arteries. These are the *right subclavian* and the *right common carotid arteries*.

(a) Right Subclavian Artery — This branch of the *brachiocephalic artery* is quite short, extending only to the first rib. It is, however, important since it continues laterally to the forearm to become the main artery of that limb. In addition, before it passes to the limb, it gives off several important arteries which supply the neck and shoulder musculature. These are the:

Costocervical Artery — This runs dorsally to the thoracic wall, thyroid, trachea, and larynx.

Internal Mammary Artery — From its origin in the *subclavian artery*, the *internal mammary artery* passes posteriorly along the inner thoracic wall. It supplies blood to the pericardium, diaphragm, thymus, and lymph nodes, to the ventral portion of the ribs, and to ventral thoracic muscles.

Vertebral Artery — This branch of the subclavian artery passes antero-medially to the sixth cervical vertebra. There it enters the *transverse foramen* and passes anteriorly through the foramina of the top six vertebrae. At the level of the brain it joins its fellow from the left side to form the *basilar artery*, which is one of the arteries which nourishes the brain.

Cervical Trunk Artery — This is a long artery, with many branches, that passes anteriorly alongside the external jugular vein. It supplies blood to the shoulder and neck muscles.

The main portion of the *right subclavian artery* continues to the forearm. Its name changes as it passes through different regions of the body.

Axillary Artery — This artery is a continuation of the *subclavian* within the axilla (armpit). It gives off several tributaries that supply the shoulder and thoracic musculature.

Brachial Artery — This is the continuation of the *axillary artery*. It proceeds from just beyond the axilla to the elbow joint, to the proximal portion of the *ulna*. Just above the elbow joint it gives off the *radial artery*, which supplies the muscles on the radius side of the forearm. The *brachial artery* then divides into two branches:

Ulnar Artery — This terminal branch of the *brachial artery* supplies blood to the paw and digits.

Median Artery — This terminal of the *brachial artery* runs along the median nerve to supply blood to the paw and digits.

(b) Right Common Carotid Artery — This is the second branch of the *brachiocephalic artery*. It passes anteriorly along the right side of the trachea, next to the internal jugular vein. At the level of the thyroid gland it bifurcates (divides into two branches). The two arteries formed are the:

Internal Carotid Artery — This artery passes deeply to the skull and onward to the base of the *brain*.

External Carotid Artery — This artery branches repeatedly to supply blood to the tongue, cheek, jaw, ear, eye, thyroid gland, and salivary glands.

2. LEFT COMMON CAROTID ARTERY — This is the second branch of the *aortic arch*. It runs anteriorly along the left side of the trachea, parallel to the *right common carotid artery*. Its path and its tributaries correspond to those of the right common carotid.

3. LEFT SUBCLAVIAN ARTERY — This is the third and final artery to branch directly from the aortic arch. It gives rise to blood vessels on the left side, corresponding to those of the *right subclavian artery* (see page 103).

Posterior Arteries

Having completed the study of the anterior arteries (those which arise from the branches of the aortic arch), we shall now turn our attention to the more posterior arteries, which form the tributaries of the *thoracic* and *abdominal aorta*.

The Dissection

Locate the *aortic arch*. Follow it dorsally and posteriorly through the thorax. Deflect the left lung toward the right and observe the *thoracic aorta* along the dorsal body wall to the left of the vertebral column. The thoracic aorta extends from the aortic arch to the *diaphragm*.

THE THORACIC AORTA

Find the following branches of the *thoracic aorta*:

Intercostal Arteries — Between every two *ribs*, note the *intercostal arteries*. They are given off by the *thoracic aorta* to the right and left sides to supply the intercostal muscles.

Anterior Phrenic Artery — This artery arising in the distal portion of the thoracic aorta supplies the anterior portion of the diaphragm.

In the rat there are no visceral branches of the thoracic aorta leading to the bronchi, esophagus, and pericardium, as in humans. Instead, these organs are supplied by branches of arteries originating from the *aortic arch*.

THE ABDOMINAL AORTA

This is a continuation of the *thoracic aorta* posteriorly. Its name is changed within the abdominal cavity. It bifurcates before entering the hind legs.

The Dissection

Follow the thoracic aorta to the *diaphragm*. With your scalpel, separate the diaphragm from the left lateral body wall and continue dorsally. Note the aorta as it passes through the diaphragm. Look for small branches of the aorta above and below the diaphragm. These are the *anterior* and *posterior phrenic arteries*. Deflect the abdominal viscera to the right and continue to trace the abdominal aorta posteriorly. At the point of bifurcation in the pelvis many smaller arteries are given off to the pelvic region, both visceral and parietal. Follow the branches of the aorta to the thigh and lower leg. **Note:** Utilize your needle probe with care; do *not* use your scalpel or scissors to separate arteries, as you will only damage or destroy them.

The *abdominal aorta* gives rise to a number of arteries supplying the organs and walls of the abdominal cavity. They will be described in the order in which they leave the aorta; from anterior to posterior. They are the:

POSTERIOR PHRENIC ARTERY — This is the first branch of the aorta below the diaphragm. It supplies blood to the diaphragm.

Anterior Adrenal Artery — This is a branch of the *posterior phrenic artery*. It leads to the anterior portion of the *adrenal gland*, a small, round nodule of glandular tissue that lies anterior to the medial border of the kidney.

CELIAC ARTERY — This short, unpaired artery leaves the aorta right below the diaphragm. It sends three branches to the viscera in the anterior abdominal cavity. These are named according to the visceral organ they serve, as follows:

Left Gastric Artery — This branch of the celiac artery passes to the cardiac end of the *stomach*, then sends branches to the lesser curvature. It joins vessels of the right gastric artery.

Splenic (Lienal) Artery — This branch of the celiac artery passes to the left, posterior to the stomach, to the *spleen*. It sends branches to the stomach and pancreas.

Hepatic Artery — This artery turns right, sending a branch posteriorly to the duodenum, then continues to the *liver*. Some of its branches include the *right gastric artery* to the stomach and the *gastroduodenal artery* to the stomach, duodenum, and pancreas.

SUPERIOR MESENTERIC ARTERY — This unpaired artery is the largest branch of the abdominal aorta. Some of its tributaries include the:

Inferior Pancreaticoduodenal Artery — to the pancreas and duodenum

Intestinal Arteries — to the jejunum and ileum

Ileocolic Artery — to the ileum, caecum, and colon

Right and Middle Colic Arteries — to the ascending colon and transverse colon, respectively.

RENAL ARTERIES — These laterally projecting branches of the abdominal aorta lead to the *kidneys*. The right renal artery arises somewhat higher than the left. It passes to the right, dorsal to the posterior vena cava.

Posterior Adrenal Artery — This is a branch of the *renal artery* that supplies the posterior portion of the *adrenal gland*.

GONADAL ARTERIES — Right below the *renal arteries*, these arteries supply blood to the *gonads*:

Spermatic (Testicular) Arteries — in males, extend to the testes.

Ovarian Arteries — in females, extend to the ovaries and horns of the uteri.

LUMBAR and **ILIOLUMBAR ARTERIES** — These arteries are below the *gonadal arteries* and pass laterally from the aorta to the musculature of the dorsal body wall. Some vessels are paired, some unpaired.

INFERIOR MESENTERIC ARTERY — This unpaired artery comes off the ventral surface of the aorta just before it bifurcates. It divides into two branches.

Left Colic Artery — passes to descending *colon*

Anterior Hemorrhoidal Artery — passes posteriorly to supply blood to the *rectum*.

MIDDLE CAUDAL ARTERY — This unpaired artery continues the course of the aorta into the *tail*.

COMMON ILIAC ARTERIES — These are the terminal branches of the abdominal aorta beyond its bifurcation. One of the *common iliac arteries* passes laterally to the right, the second to the left. Before leaving the abdominal cavity, several branches are given off to the viscera of the pelvis and its musculature.

The *common iliac arteries* also divide into two main branches. They are the *internal iliac (hypogastric) arteries* and the *external iliac arteries*.

Note: The branching of the common iliac arteries is variable in different specimens. Your specimen may show a pattern different from that described here.

Internal Iliac (Hypogastric) Artery — This artery is a large trunk arising from the common iliac artery at the level of the sacro-iliac joint. Some of the arteries supplying the pelvic viscera, the intestinal and urogenital organs, are the:

Anterior and Posterior Vesical Arteries
Deferential Artery (in males)
Uterine and *Vaginal Arteries* (in females)
Middle Hemorrhoidal Artery
Internal Pudendal Artery

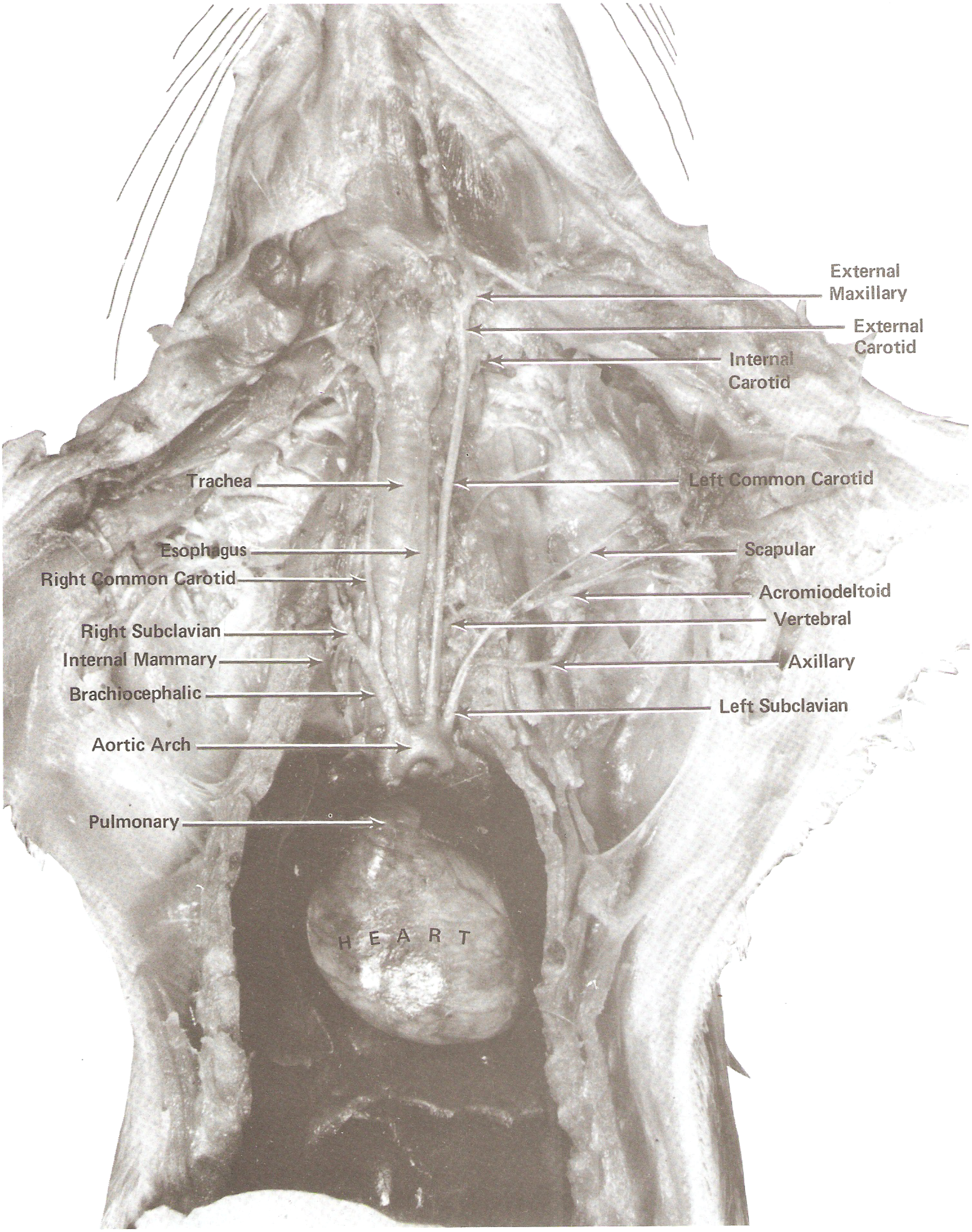
Those supplying the pelvic body walls include the:

Obturator Artery
Medial and Lateral Femoral Circumflex Arteries
Posterior External Pudendal Artery
Posterior Epigastric Artery
External Spermatic Artery (not present in females)
Posterior and *Anterior Gluteal Arteries*

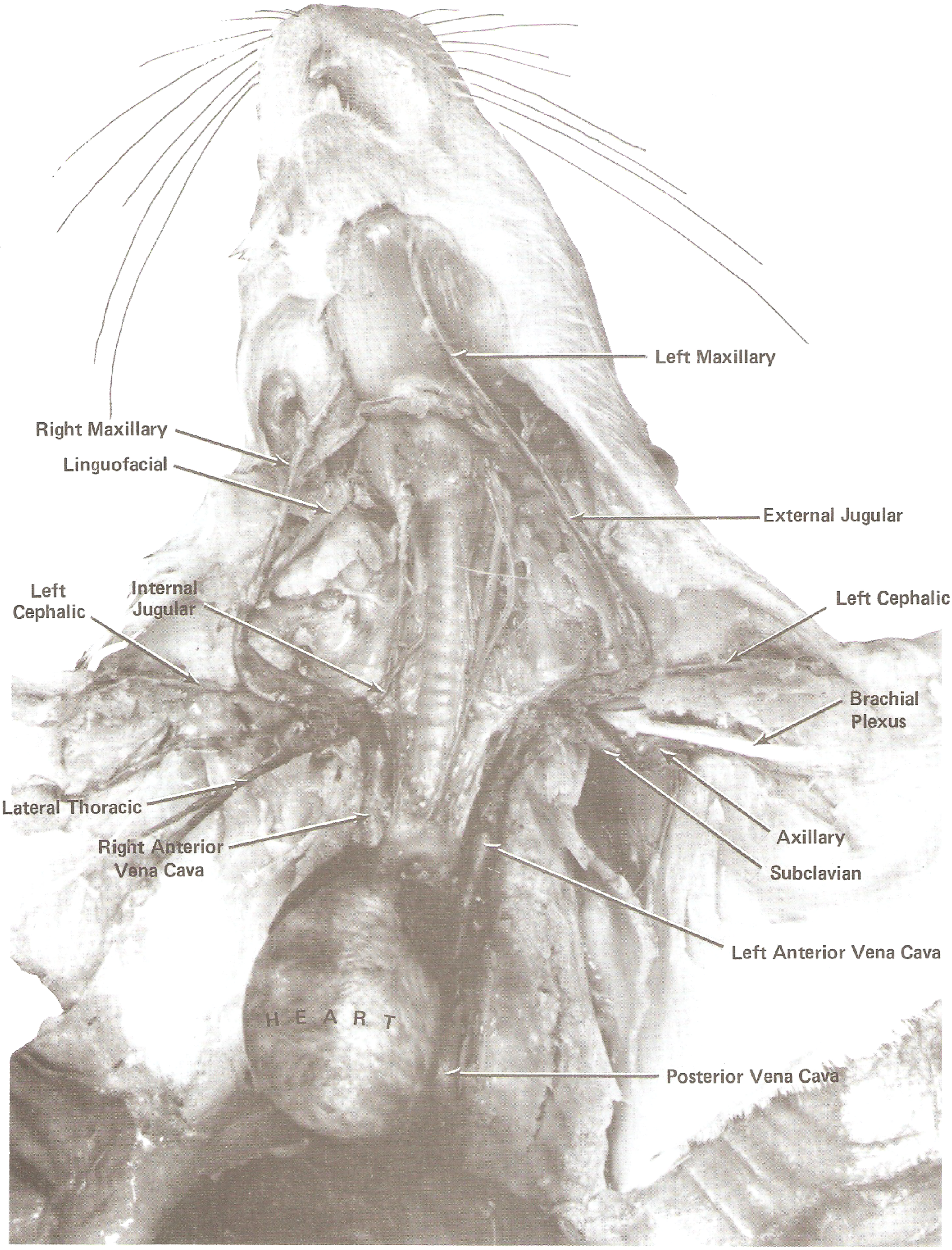
External Iliac Artery — Like the internal iliac, this artery gives off branches to the pelvic musculature and viscera. Its main pelvic tributary is the *pudic-epigastric artery*. It then passes out of the abdominal cavity as the *femoral artery* and continues along the medial surface of the thigh to the distal portion of the hind leg.

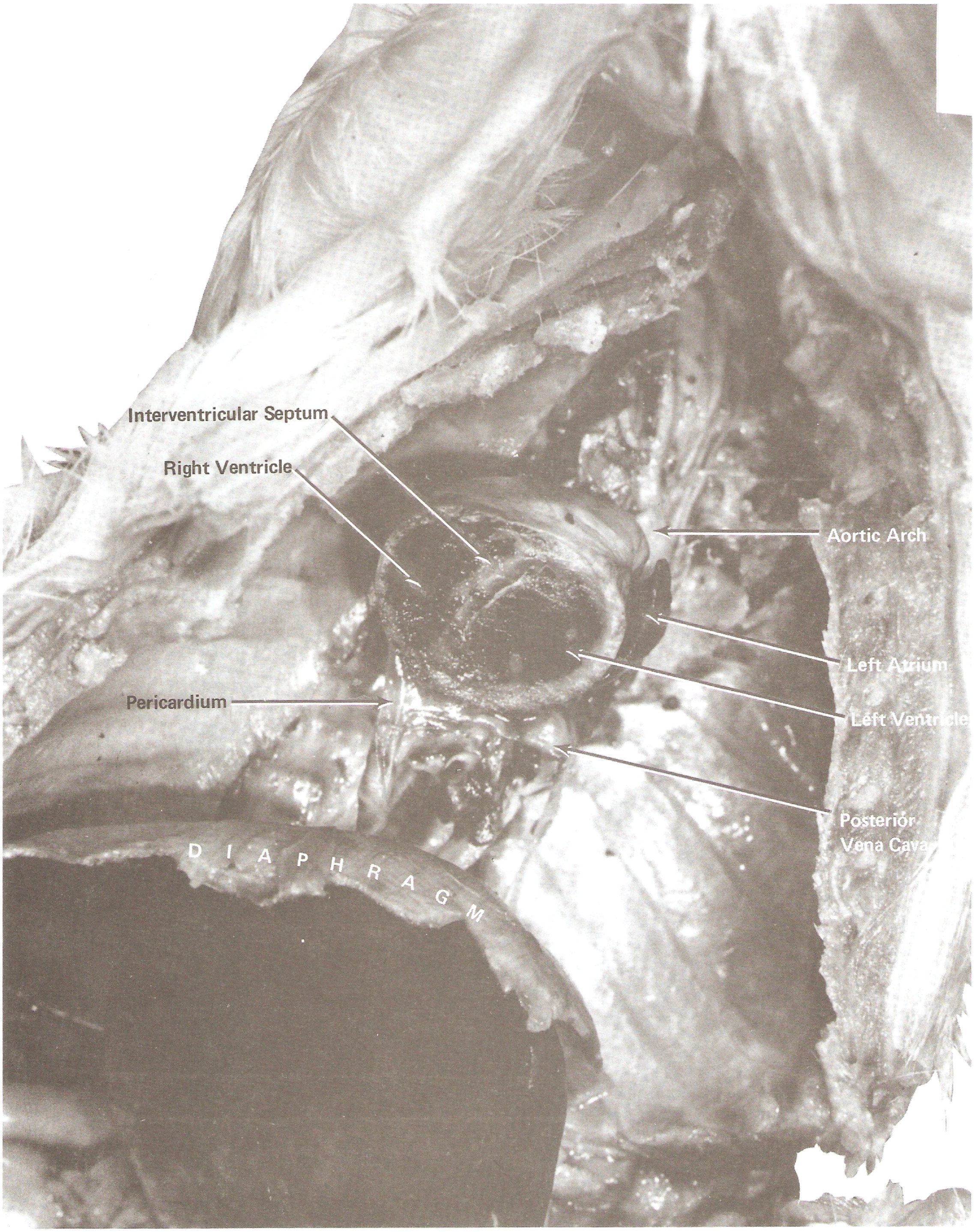
Femoral Artery — This vessel is a continuation of the *external iliac artery* down the medial side of the thigh. It passes distally to the *popliteal fossa* at the back of the *knee*. It is here known as the *popliteal artery*. A branch, the *great saphenous artery*, runs superficially down the medial surface of the leg to the ankle.

Popliteal Artery — This short artery soon divides as it passes further to the distal parts of the leg. Some of its branches are the *genicular arteries*, and the *posterior* and *anterior tibial arteries*. Further branching extends the arterial system to the feet and the digits.

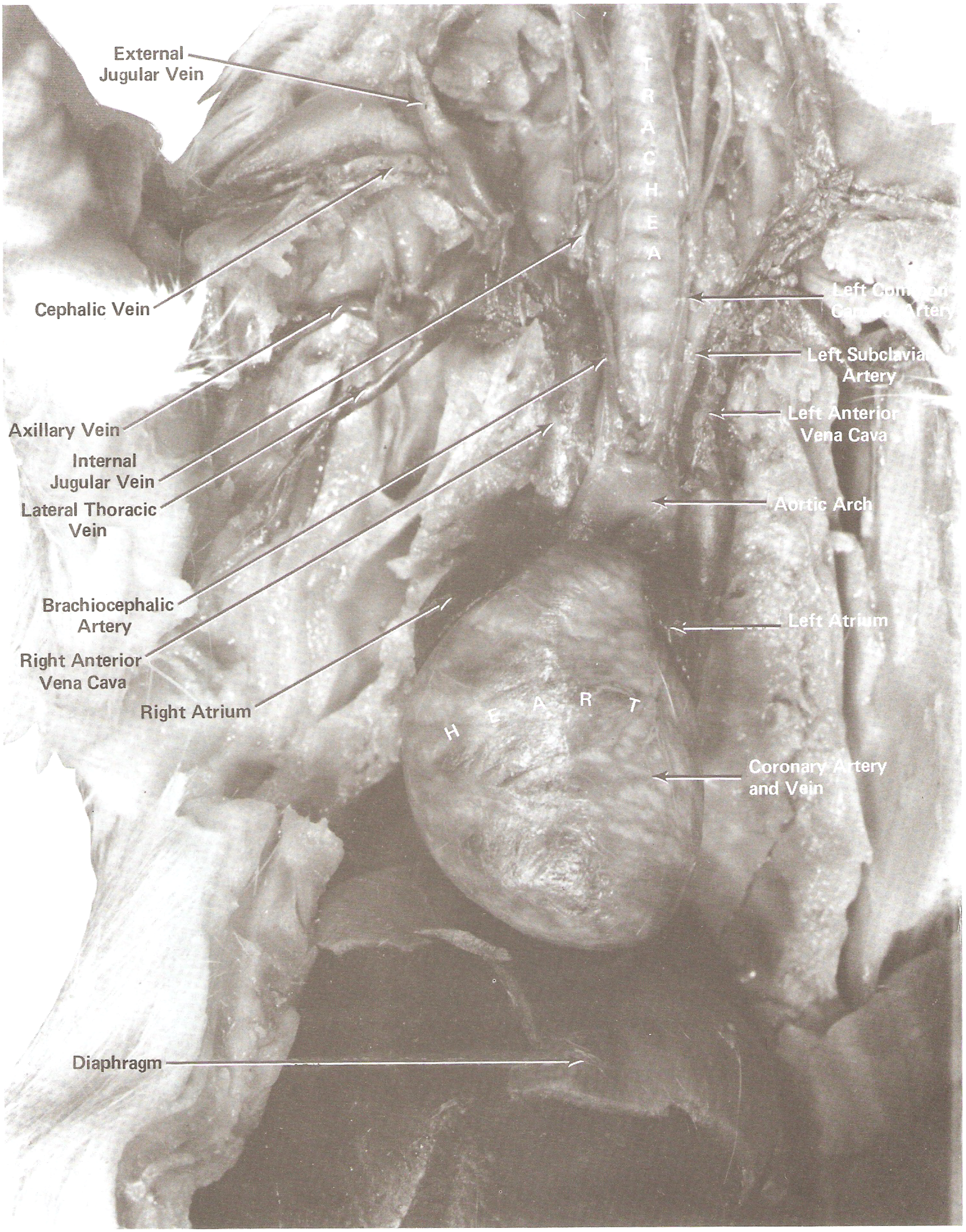


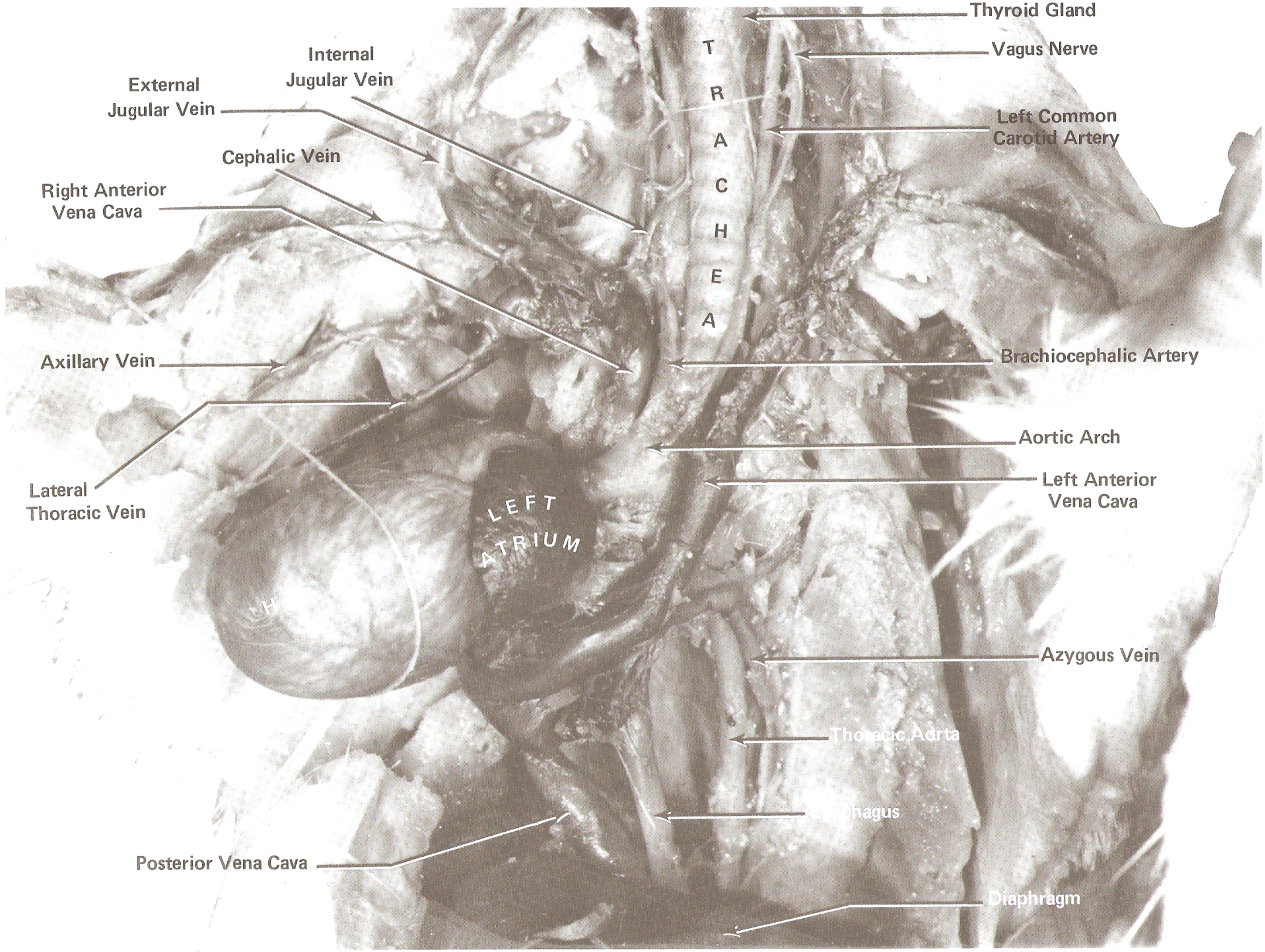
ANTERIOR ARTERIES


Left Maxillary
Right Maxillary
Linguofacial
External Jugular
Left Cephalic
Internal Jugular
Left Cephalic
Brachial Plexus
Lateral Thoracic
Right Anterior Vena Cava
Axillary
Subclavian
Left Anterior Vena Cava
HEART
Posterior Vena Cava

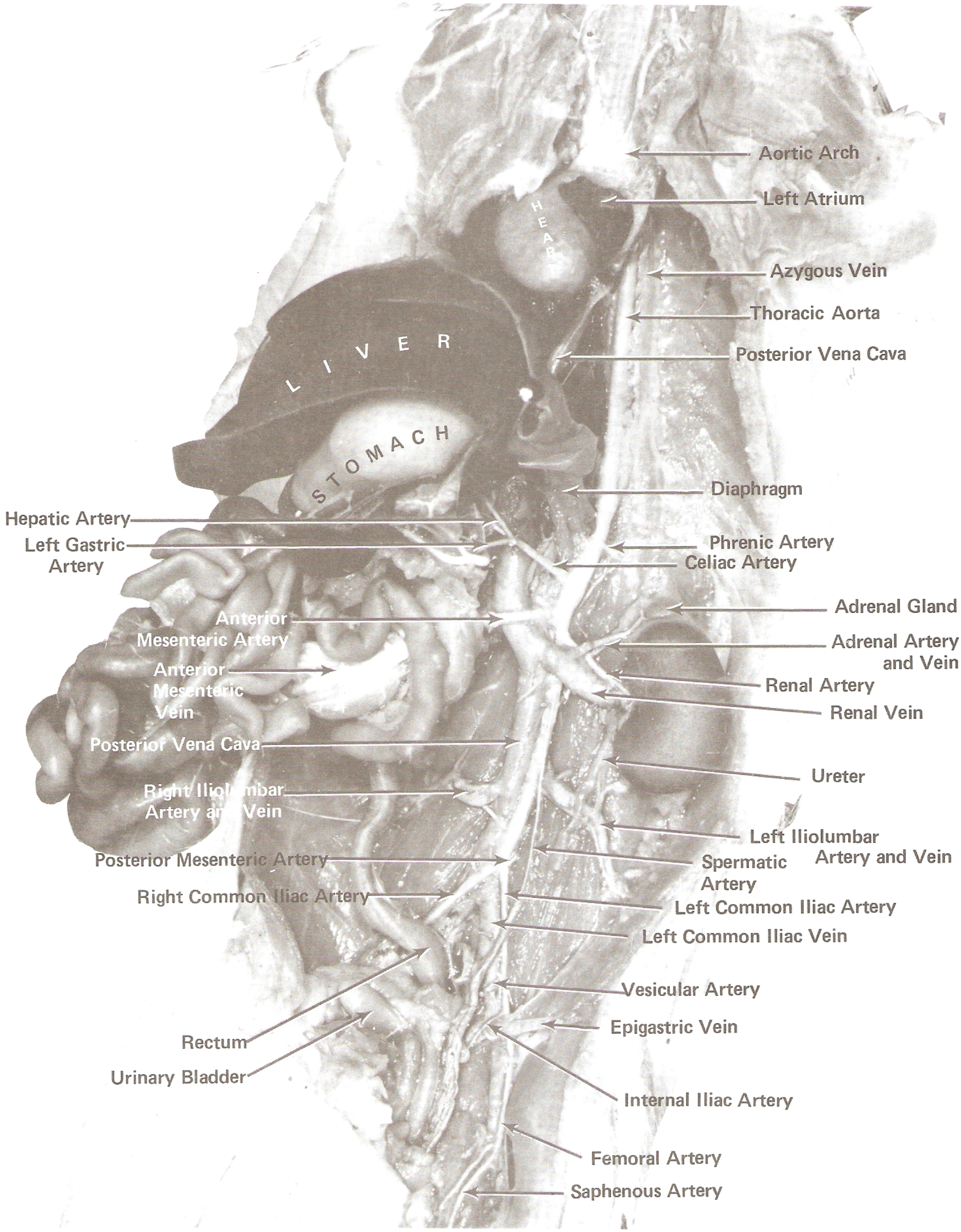


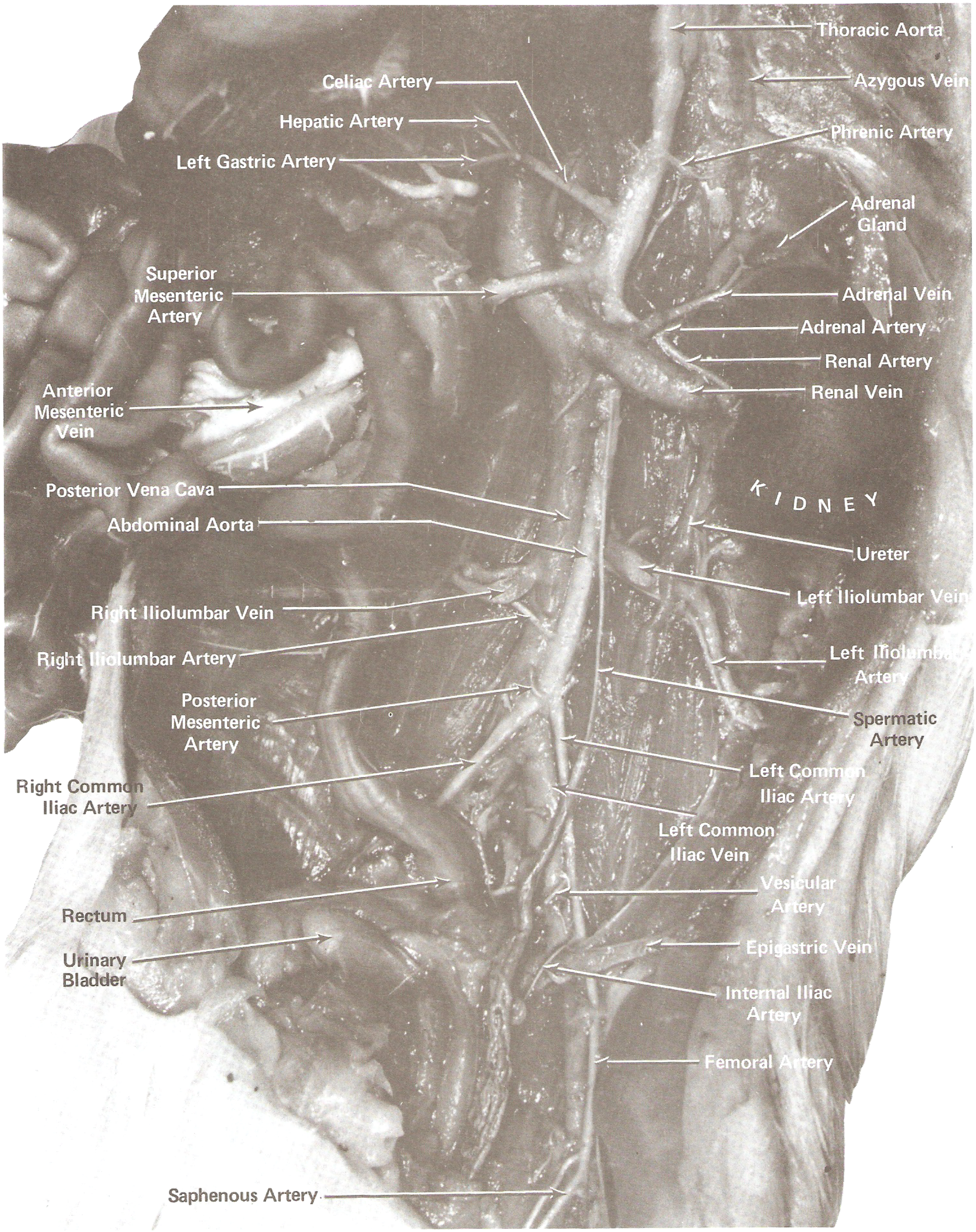
HEART (Cross-Section)

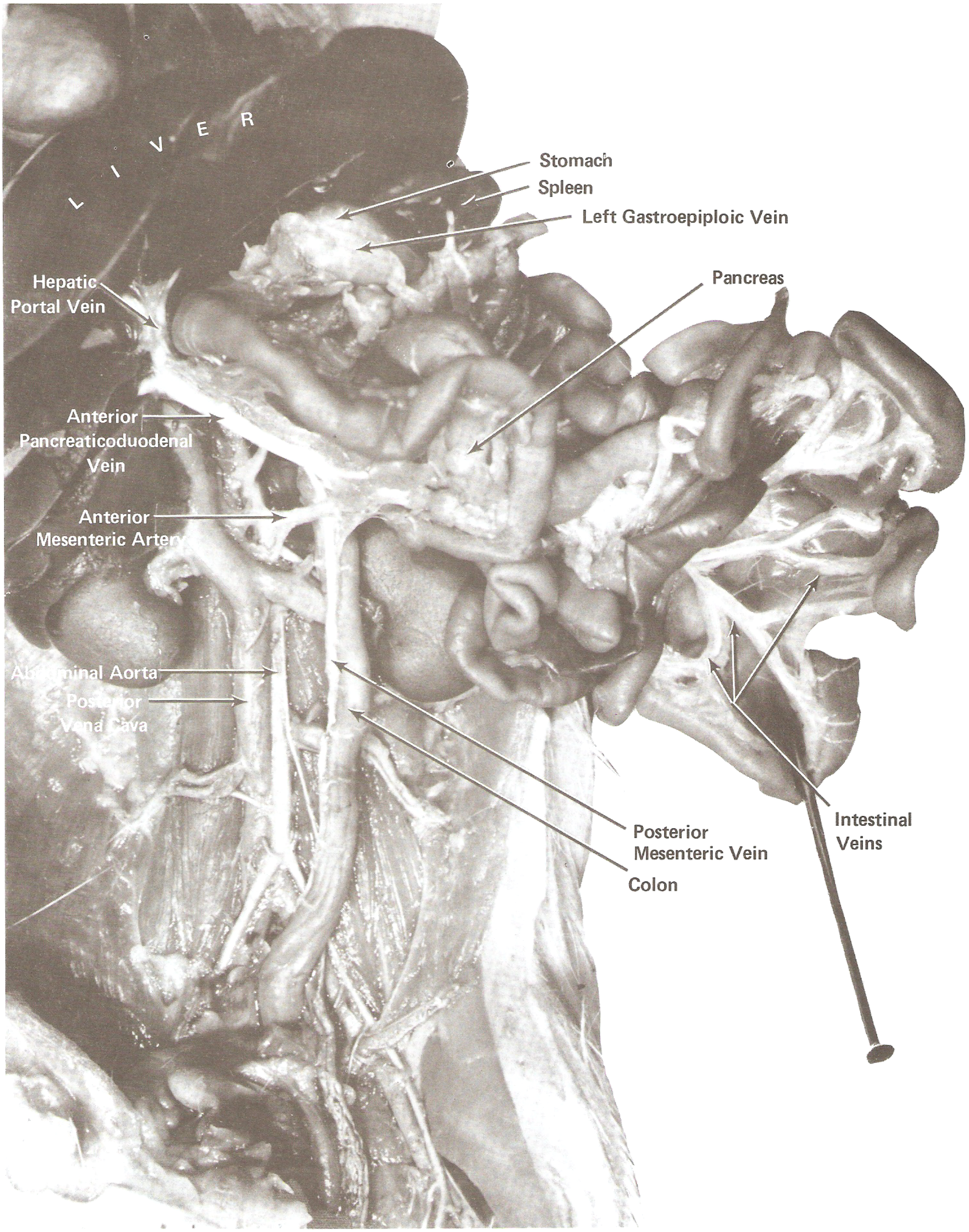

External Jugular Vein
Cephalic Vein
Axillary Vein
Internal Jugular Vein
Lateral Thoracic Vein
Brachiocephalic Artery
Right Anterior Vena Cava
Right Atrium
Diaphragm
TRACHEA
Left Common Carotid Artery
Left Subclavian Artery
Left Anterior Vena Cava
Aortic Arch
Left Atrium
HEART
Coronary Artery and Vein



HEART AND MAJOR BLOOD VESSELS


Aortic Arch
Left Atrium
HEART
Azygous Vein
Thoracic Aorta
Posterior Vena Cava
LIVER
STOMACH
Diaphragm
Hepatic Artery
Left Gastric Artery
Phrenic Artery
Celiac Artery
Adrenal Gland
Anterior Mesenteric Artery
Adrenal Artery and Vein
Anterior Mesenteric Vein
Renal Artery
Renal Vein
Posterior Vena Cava
Ureter
Right Iliolumbar Artery and Vein
Left Iliolumbar Artery and Vein
Posterior Mesenteric Artery
Spermatic Artery
Right Common Iliac Artery
Left Common Iliac Artery
Left Common Iliac Vein
Vesicular Artery
Epigastric Vein
Rectum
Urinary Bladder
Internal Iliac Artery
Femoral Artery
Saphenous Artery


Thoracic Aorta
Azygous Vein
Celiac Artery
Hepatic Artery
Phrenic Artery
Left Gastric Artery
Adrenal Gland
Superior Mesenteric Artery
Adrenal Vein
Adrenal Artery
Renal Artery
Anterior Mesenteric Vein
Renal Vein
KIDNEY
Posterior Vena Cava
Abdominal Aorta
Ureter
Left Iliolumbar Vein
Right Iliolumbar Vein
Right Iliolumbar Artery
Left Iliolumbar Artery
Posterior Mesenteric Artery
Spermatic Artery
Left Common Iliac Artery
Right Common Iliac Artery
Left Common Iliac Vein
Vesicular Artery
Rectum
Epigastric Vein
Urinary Bladder
Internal Iliac Artery
Femoral Artery
Saphenous Artery


L I V E R
Stomach
Spleen
Left Gastroepiploic Vein
Pancreas
Hepatic Portal Vein
Anterior Pancreaticoduodenal Vein
Anterior Mesenteric Artery
Abdominal Aorta
Posterior Vena Cava
Posterior Mesenteric Vein
Colon
Intestinal Veins