

## Exercise 6: Blood Vessels: Inferior

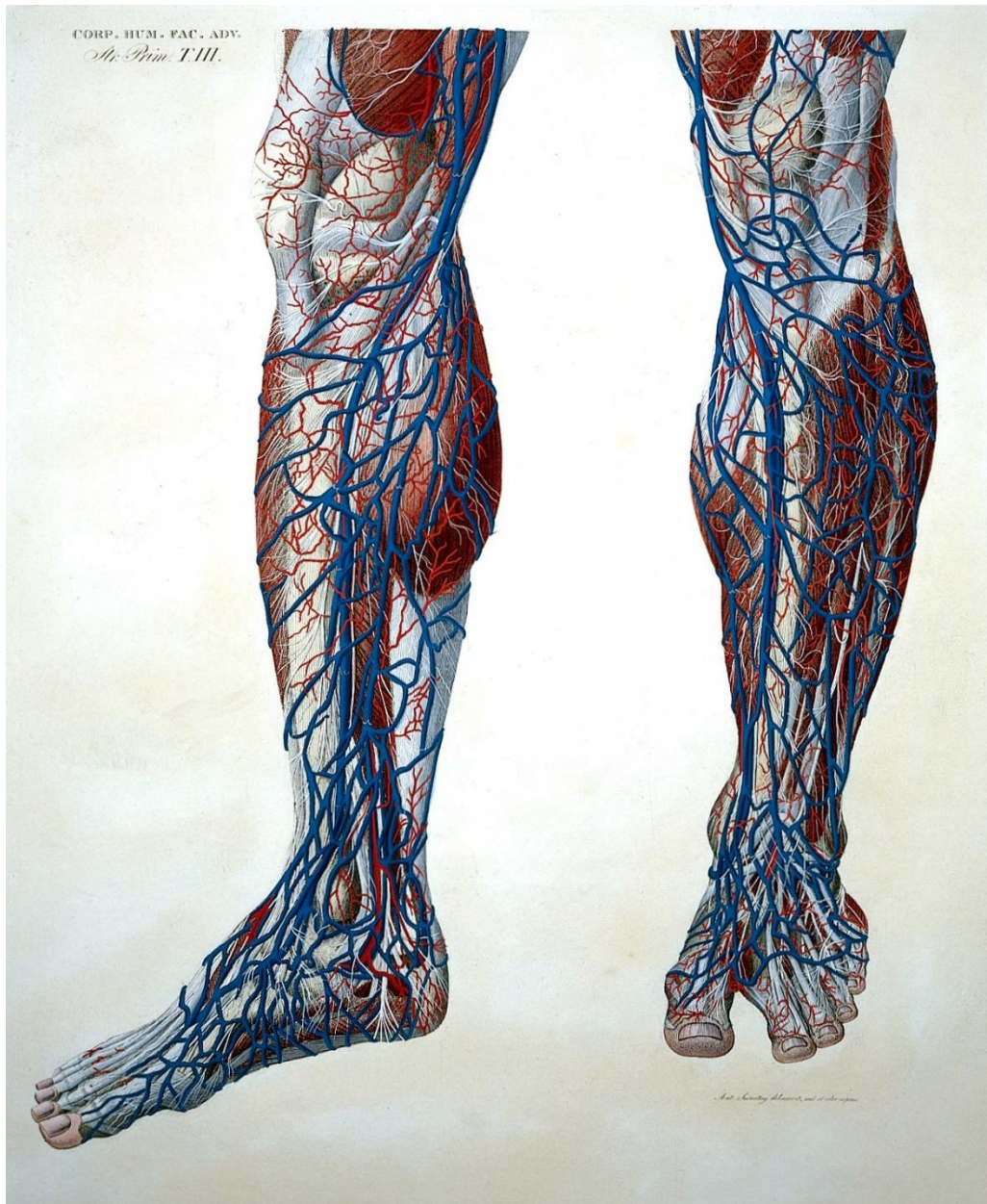


Figure 6.1 : Blood vessels of the lower legs by P. Mascagni.  
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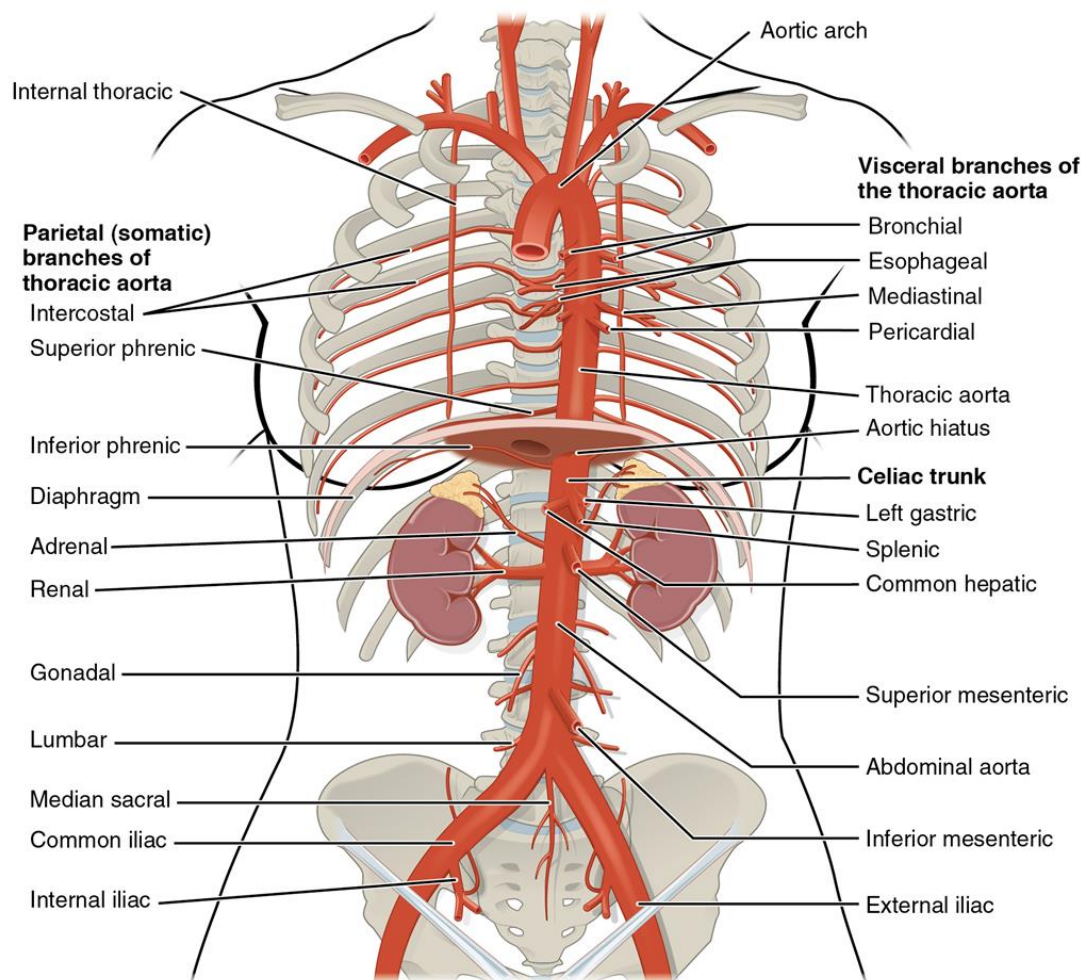
### Exercise 6 Learning Goals

After completing this lab, you should be able to:

- Continue to identify the differences in histology of arteries and veins.
- Identify and describe the major arteries and veins of the human lower body
- Gross identification of arteries, veins and nerves from a dissection specimen

## Pre-Lab Activity 6.1: Thoracic Aorta and Major Branches

The thoracic aorta begins at the level of vertebra T5 and continues through to the diaphragm at the level of T12, initially traveling within the mediastinum to the left of the vertebral column. As it passes through the thoracic region, the thoracic aorta gives rise to several branches, which are collectively referred to as visceral branches and parietal branches. Those branches that supply blood primarily to visceral organs are known as the **visceral branches** and include the bronchial arteries, pericardial arteries, esophageal arteries, and the mediastinal arteries, each named after the tissues it supplies. Each **bronchial artery** (typically two on the left and one on the right) supplies systemic blood to the lungs and visceral pleura, in addition to the blood pumped to the lungs for oxygenation via the pulmonary circuit. The bronchial arteries follow the same path as the respiratory branches, beginning with the bronchi and ending with the bronchioles. There is considerable, but not total, intermingling of the systemic and pulmonary blood at anastomoses in the smaller branches of the lungs. This may sound incongruous—that is, the mixing of systemic arterial blood high in oxygen with the pulmonary arterial blood lower in oxygen—but the systemic vessels also deliver nutrients to the lung tissue just as they do elsewhere in the body. The mixed blood drains into typical pulmonary veins, whereas the bronchial artery branches remain separate and drain into bronchial veins described later. Each **pericardial artery** supplies blood to the pericardium, the **esophageal artery** provides blood to the esophagus, and the **mediastinal artery** provides blood to the mediastinum. The remaining thoracic aorta branches are collectively referred to as **parietal branches** or somatic branches, and include the intercostal and superior phrenic arteries. Each **intercostal artery** provides blood to the muscles of the thoracic cavity and vertebral column. The **superior phrenic artery** provides blood to the superior surface of the diaphragm.



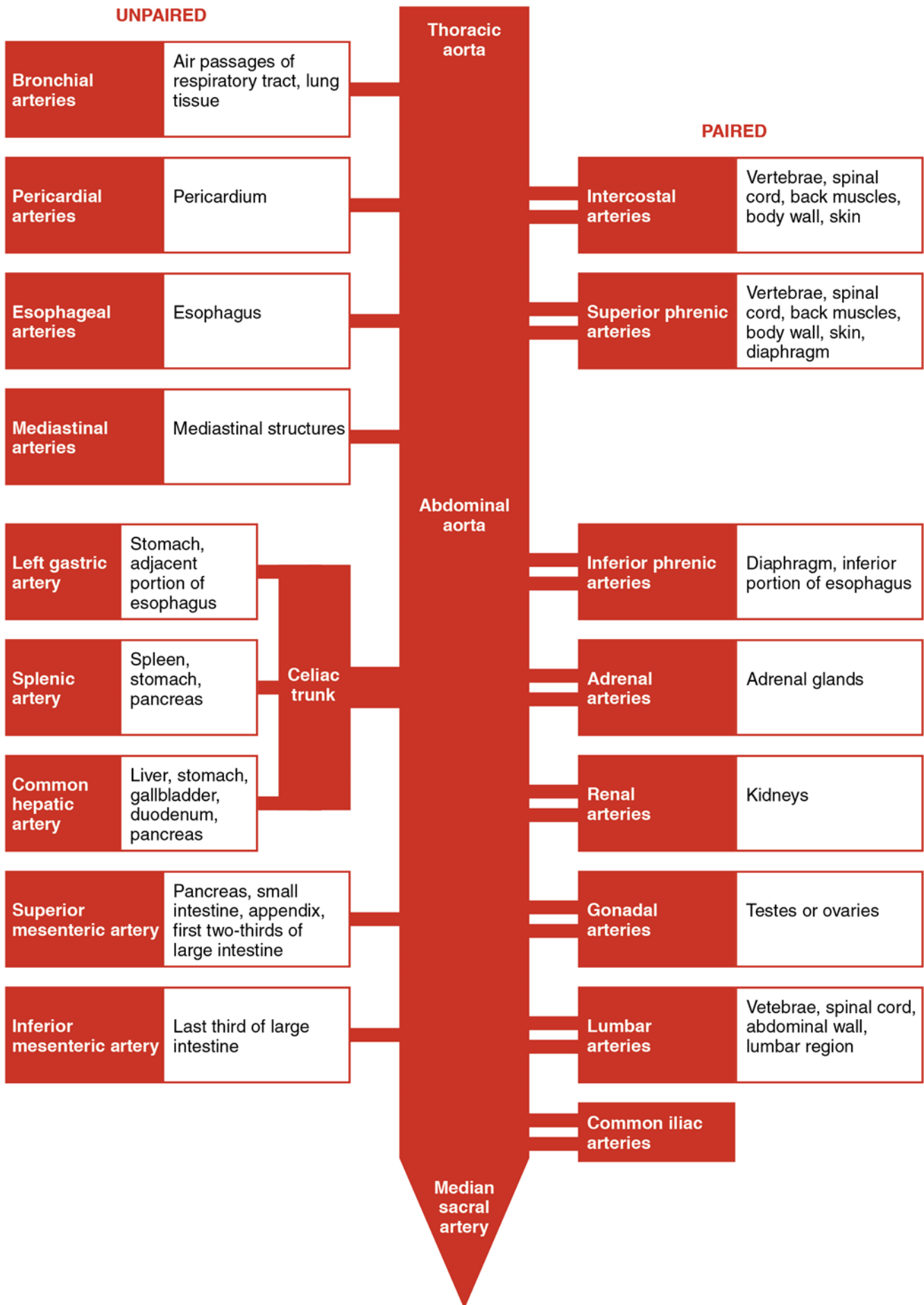
## Pre-Lab 6.2 Abdominal Aorta and Major Branches

After crossing through the diaphragm at the aortic hiatus, the thoracic aorta is called the abdominal aorta. This vessel remains to the left of the vertebral column and is embedded in adipose tissue behind the peritoneal cavity. It formally ends at approximately the level of vertebra L4, where it bifurcates to form the common iliac arteries. Before this division, the abdominal aorta gives rise to several important branches. A single celiac trunk (artery) emerges and divides into the left gastric artery to supply blood to the stomach and esophagus, the splenic artery to supply blood to the spleen, and the common hepatic artery, which in turn gives rise to the hepatic artery proper to supply blood to the liver, the right gastric artery to supply blood to the stomach, the cystic artery to supply blood to the gall bladder, and several branches, one to supply blood to the duodenum and another to supply blood to the pancreas. Two additional single vessels arise from the abdominal aorta. These are the superior and inferior mesenteric arteries. The superior mesenteric artery arises approximately 2.5 cm after the celiac trunk and branches into several major vessels that supply blood to the small intestine (duodenum, jejunum, and ileum), the pancreas, and a majority of the large intestine. The inferior mesenteric artery supplies blood to the distal segment of the large intestine, including the rectum. It arises approximately 5 cm superior to the common iliac arteries.

In addition to these single branches, the abdominal aorta gives rise to several significant paired arteries along the way. These include the inferior phrenic arteries, the adrenal arteries, the renal arteries, the gonadal arteries, and the lumbar arteries. Each inferior phrenic artery is a counterpart of a superior phrenic artery and supplies blood to the inferior surface of the diaphragm. The adrenal artery supplies blood to the adrenal (suprarenal) glands and arises near the superior mesenteric artery. Each renal artery branches approximately 2.5 cm inferior to the superior mesenteric arteries and supplies a kidney. The right renal artery is longer than the left since the aorta lies to the left of the vertebral column and the vessel must travel a greater distance to reach its target. Renal arteries branch repeatedly to supply blood to the kidneys. Each gonadal artery supplies blood to the gonads, or reproductive organs, and is also described as either an ovarian artery or a testicular artery (internal spermatic), depending upon the sex of the individual. An ovarian artery supplies blood to an ovary, uterine (Fallopian) tube, and the uterus, and is located within the suspensory ligament of the uterus. It is considerably shorter than a testicular artery, which ultimately travels outside the body cavity to the testes, forming one component of the spermatic cord. The gonadal arteries arise inferior to the renal arteries and are generally retroperitoneal. The ovarian artery continues to the uterus where it forms an anastomosis with the uterine artery that supplies blood to the uterus. Both the uterine arteries and vaginal arteries, which distribute blood to the vagina, are branches of the internal iliac artery. The four paired lumbar arteries are the counterparts of the intercostal arteries and supply blood to the lumbar region, the abdominal wall, and the spinal cord. In some instances, a fifth pair of lumbar arteries emerges from the median sacral artery.

The aorta divides at approximately the level of vertebra L4 into a left and a right common iliac artery but continues as a small vessel, the median sacral artery, into the sacrum. The common iliac arteries provide blood to the pelvic region and ultimately to the lower limbs. They split into external and internal iliac arteries approximately at the level of the lumbar-sacral articulation. Each internal iliac artery sends branches to the urinary bladder, the walls of the pelvis, the external genitalia, and the medial portion of the femoral region. In females, they also provide blood to the uterus and vagina. The much larger external iliac artery supplies blood to each of the lower limbs. Figure 20.29 shows the distribution of the major branches of the aorta into the thoracic and abdominal regions. Figure 20.30 shows the distribution of the major branches of the common iliac arteries

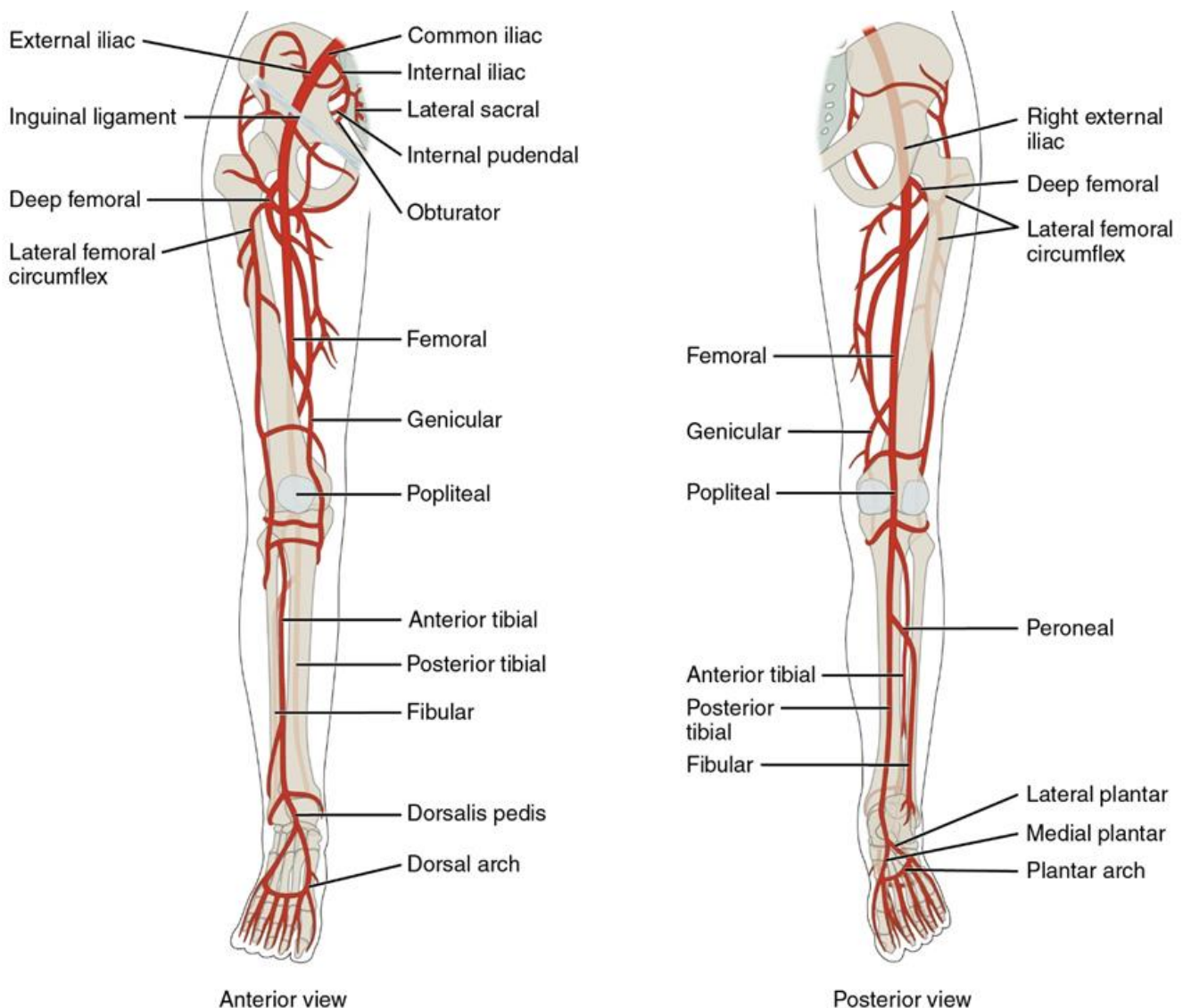




## Pre-Lab 6.3 Arteries Serving the Lower Limbs

The external iliac artery exits the body cavity and enters the femoral region of the lower leg. As it passes through the body wall, it is renamed the **femoral artery**. It gives off several smaller branches as well as the lateral **deep femoral artery** that in turn gives rise to a **lateral circumflex artery**. These arteries supply blood to the deep muscles of the thigh as well as ventral and lateral regions of the integument. The femoral artery also gives rise to the **genicular artery**, which provides blood to the region of the knee. As the femoral artery passes posterior to the knee near the popliteal fossa, it is called the popliteal artery. The **popliteal artery** branches into the anterior and posterior tibial arteries. The **popliteal artery** branches into the anterior and posterior tibial arteries.

The **anterior tibial artery** is located between the tibia and fibula, and supplies blood to the muscles and integument of the anterior tibial region. Upon reaching the tarsal region, it becomes the **dorsalis pedis artery**, which branches repeatedly and provides blood to the tarsal and dorsal regions of the foot. The **posterior tibial artery** provides blood to the muscles and integument on the posterior surface of the tibial region. The fibular or peroneal artery branches from the posterior tibial artery. It bifurcates and becomes the **medial plantar artery** and **lateral plantar artery**, providing blood to the plantar surfaces. There is an anastomosis with the dorsalis pedis artery, and the medial and lateral plantar arteries form two arches called the **dorsal arch** (also called the arcuate arch) and the **plantar arch**, which provide blood to the remainder of the foot and toes.



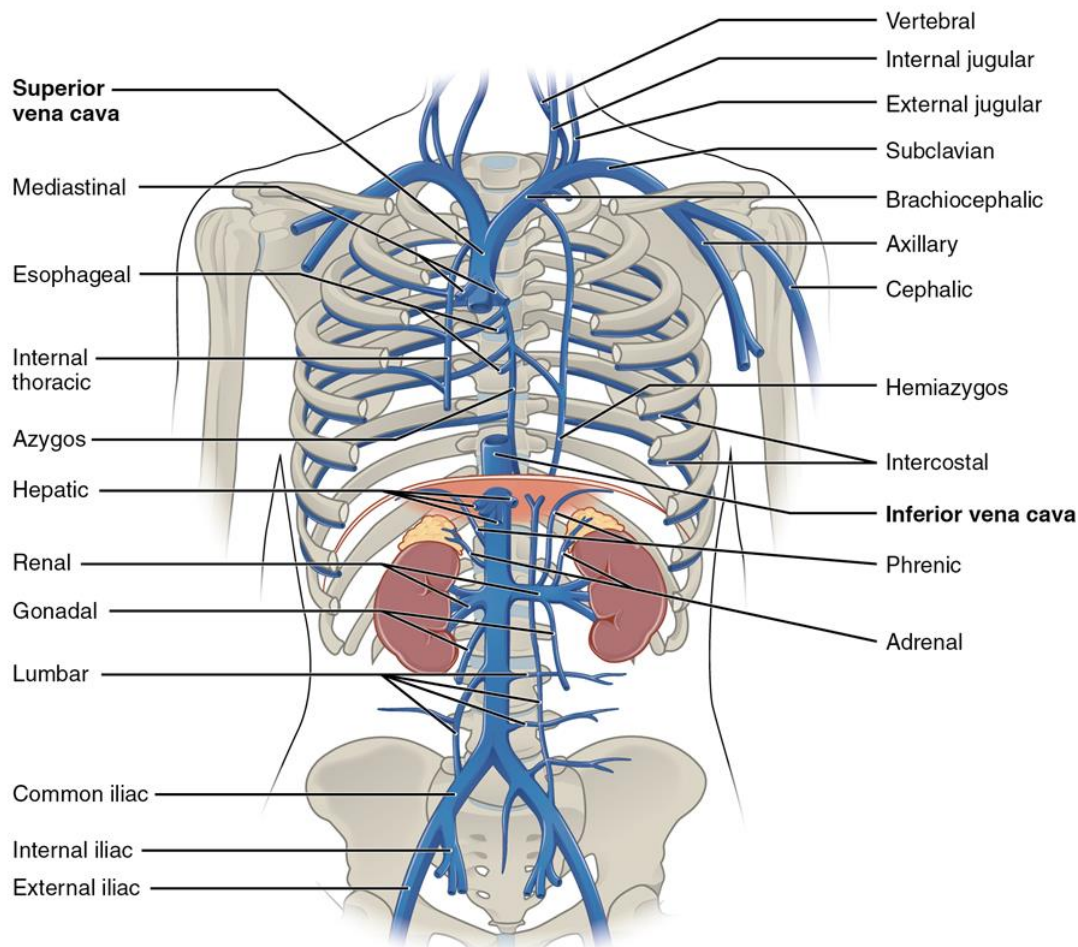
## Pre-Lab 6.4 The Inferior Vena Cava

Other than the small amount of blood drained by the azygos and hemiazygos veins, most of the blood inferior to the diaphragm drains into the inferior vena cava before it is returned to the heart. Lying just beneath the parietal peritoneum in the abdominal cavity, the **inferior vena cava** parallels the abdominal aorta, where it can receive blood from abdominal veins. The lumbar portions of the abdominal wall and spinal cord are drained by a series of **lumbar veins**, usually four on each side. The ascending lumbar veins drain into either the azygos vein on the right or the hemiazygos vein on the left, and return to the superior vena cava. The remaining lumbar veins drain directly into the inferior vena cava.

Blood supply from the kidneys flows into each **renal vein**, normally the largest veins entering the inferior vena cava. A number of other, smaller veins empty into the left renal vein. Each **adrenal vein** drains the adrenal or suprarenal glands located immediately superior to the kidneys. The right adrenal vein enters the inferior vena cava directly, whereas the left adrenal vein enters the left renal vein.

From the male reproductive organs, each **testicular vein** flows from the scrotum, forming a portion of the spermatic cord. Each **ovarian vein** drains an ovary in females. Each of these veins is generically called a **gonadal vein**. The right gonadal vein empties directly into the inferior vena cava, and the left gonadal vein empties into the left renal vein.

Each side of the diaphragm drains into a **phrenic vein**; the right phrenic vein empties directly into the inferior vena cava, whereas the left phrenic vein empties into the left renal vein. Blood supply from the liver drains into each **hepatic vein** and directly into the inferior vena cava. Since the inferior vena cava lies primarily to the right of the vertebral column and aorta, the left renal vein is longer, as are the left phrenic, adrenal, and gonadal veins. The longer length of the left renal vein makes the left kidney the primary target of surgeons removing this organ for donation

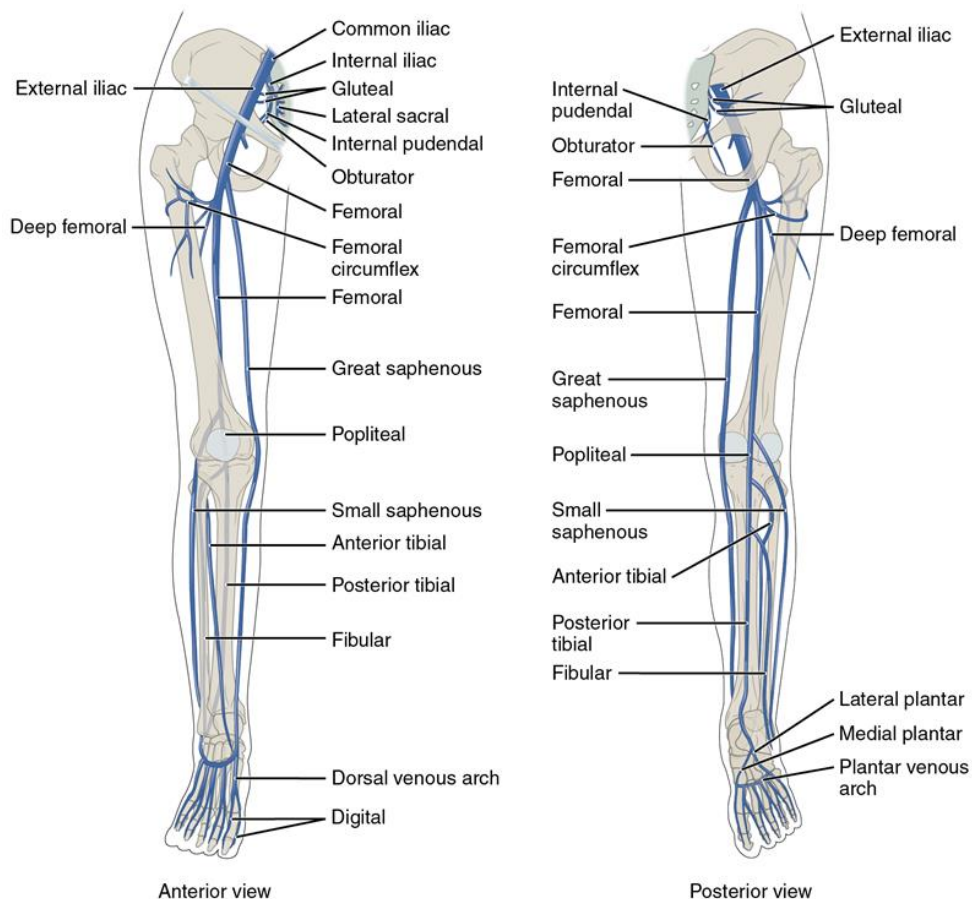


## Pre-Lab 6.6 Veins Draining the Lower Limbs

The superior surface of the foot drains into the digital veins, and the inferior surface drains into the **plantar veins**, which flow into a complex series of anastomoses in the feet and ankles, including the **dorsal venous arch** and the **plantar venous**. From the dorsal venous arch, blood supply drains into the anterior and posterior tibial veins. The **anterior tibial vein** drains the area near the tibialis anterior muscle and combines with the posterior tibial vein and the fibular vein to form the popliteal vein. The **posterior tibial vein** drains the posterior surface of the tibia and joins the popliteal vein. The **fibular vein** drains the muscles and integument in proximity to the fibula and also joins the popliteal vein. The **small saphenous vein** located on the lateral surface of the leg drains blood from the superficial regions of the lower leg and foot, and flows into to the **popliteal vein**. As the popliteal vein passes behind the knee in the popliteal region, it becomes the femoral vein. It is palpable in patients without excessive adipose tissue.

Close to the body wall, the great saphenous vein, the deep femoral vein, and the femoral circumflex vein drain into the femoral vein. The **great saphenous vein** is a prominent surface vessel located on the medial surface of the leg and thigh that collects blood from the superficial portions of these areas. The **deep femoral vein**, as the name suggests, drains blood from the deeper portions of the thigh. The **femoral circumflex vein** forms a loop around the femur just inferior to the trochanters and drains blood from the areas in proximity to the head and neck of the femur.

As the **femoral vein** penetrates the body wall from the femoral portion of the upper limb, it becomes the **external iliac vein**, a large vein that drains blood from the leg to the common iliac vein. The pelvic organs and integument drain into the **internal iliac vein**, which forms from several smaller veins in the region, including the umbilical veins that run on either side of the bladder. The external and internal iliac veins combine near the inferior portion of the sacroiliac joint to form the common iliac vein. In addition to blood supply from the external and internal iliac veins, the **middle sacral vein** drains the sacral region into the **common iliac vein**. Similar to the common iliac arteries, the common iliac veins come together at the level of L5 to form the inferior vena cava.



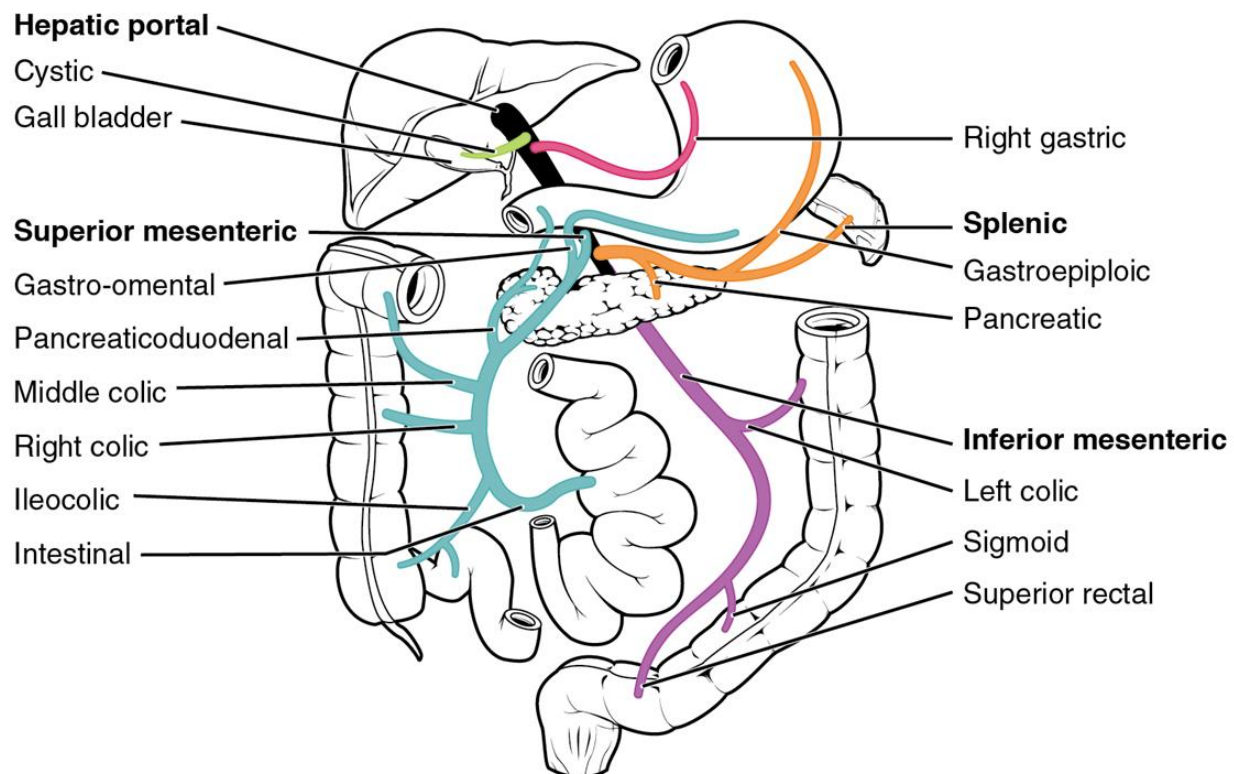


## Pre-Lab 6.7 Hepatic Portal System

The liver is a complex biochemical processing plant. It packages nutrients absorbed by the digestive system; produces plasma proteins, clotting factors, and bile; and disposes of worn-out cell components and waste products. Instead of entering the circulation directly, absorbed nutrients and certain wastes (for example, materials produced by the spleen) travel to the liver for processing. They do so via the **hepatic portal system**. Portal systems begin and end in capillaries. In this case, the initial capillaries from the stomach, small intestine, large intestine, and spleen lead to the hepatic portal vein and end in specialized capillaries within the liver, the hepatic sinusoids. You saw the only other portal system with the hypothalamic-hypophyseal portal vessel in the endocrine chapter.

The hepatic portal system consists of the hepatic portal vein and the veins that drain into it. The hepatic portal vein itself is relatively short, beginning at the level of L2 with the confluence of the superior mesenteric and splenic veins. It also receives branches from the inferior mesenteric vein, plus the splenic veins and all their tributaries. The superior mesenteric vein receives blood from the small intestine, two-thirds of the large intestine, and the stomach. The inferior mesenteric vein drains the distal third of the large intestine, including the descending colon, the sigmoid colon, and the rectum. The splenic vein is formed from branches from the spleen, pancreas, and portions of the stomach, and the inferior mesenteric vein. After its formation, the hepatic portal vein also receives branches from the gastric veins of the stomach and cystic veins from the gall bladder. The hepatic portal vein delivers materials from these digestive and circulatory organs directly to the liver for processing.

Because of the hepatic portal system, the liver receives its blood supply from two different sources: from normal systemic circulation via the hepatic artery and from the hepatic portal vein. The liver processes the blood from the portal system to remove certain wastes and excess nutrients, which are stored for later use. This processed blood, as well as the systemic blood that came from the hepatic artery, exits the liver via the right, left, and middle hepatic veins, and flows into the inferior vena cava. Overall systemic blood composition remains relatively stable, since the liver is able to metabolize the absorbed digestive components.





## Lab 6 Activities

### Structures to Identify:

#### Arteries:

- Aorta – abdominal
- Celiac artery
- Superior mesenteric artery
- Adrenolumbar artery (R&L)
- Renal artery (R&L)
- Inferior mesenteric artery
- Gonadal artery (R&L)
- Internal iliac artery (R&L)
- Umbilical artery (R&L)
- Median sacral artery
- External iliac artery (R&L)
- Iliolumbar artery (R&L)
- Femoral artery (R&L)
- Deep femoral (R&L)

#### Veins:

- Inferior vena cava
- Umbilical vein (cut)
- Hepatic veins
- Hepatic portal vein
- Renal vein (R&L)
- Common iliac vein (R&L)
- Internal iliac vein (R&L)
- External iliac vein (R&L)

## Lab Activity 6.1 Fetal Pig Dissection

Supplies needed: Gloves, scalpel, blunt probe, tweezers

For the **POSTERIOR** portion of the fetal pig circulatory system:

These are analogous to the **INFERIOR** vessels of the human circulatory system. Use human terminology where ever terms for the pig may differ.

1. The blood vessels of the abdominal organs lie deep within the abdominal cavity, underneath the parietal peritoneum (layer of serous membrane which lines the abdominal cavity). Hence, the blood vessels are said to be retroperitoneal (behind the peritoneum). In order to see the blood vessels you will need to use your probe/tweezers to peel off the peritoneum. BE CAREFUL as you do this. The vessels, especially the arteries that you are looking for here, are much smaller than the anterior vessels. Be sure you do not tear these out as you are removing the peritoneum. Aside from peeling back the peritoneum, there is no other tissue that should be removed from the abdominal cavity.
2. To fully open the abdominal flaps you originally cut, you will have to cut the **umbilical vein** leading from the internal aspect of the umbilicus to the liver. Cut it midway along its length so you can “reconnect” the two halves during identification.
3. Identify the **arteries** that supply the posterior portion of the fetal pig (inferior in humans) :

- **Abdominal aorta** – begins where the aorta passes through the diaphragm; is the source which all the posterior (inferior) arteries branch from; runs parallel with the spinal column – usually appears undyed because of its thick, muscular walls.
- **Celiac artery** - first branch off the abdominal aorta; supplies the stomach, liver and spleen with blood.
- **Superior mesenteric artery** –located immediately after the celiacartery; supplies the small intestine.
- **Adrenolumbar arteries (R&L)** - branch off just below the superior mesenteric and can best be seen by lifting up a kidney; supply the tissue of the abdominal wall underneath the kidney
- **Renal arteries (R&L)** - branch off of the aorta immediately after the adrenolumbars; can be seen entering the hilum of each kidney

Near the base of the aorta, three small, thread-like arteries branch off.

- **Inferior mesenteric artery** - runs medially along the underside of the descending colon; supplies the lower small intestines and large intestines.
- **Gonadal arteries (R&L)** – branch laterally; supply the gonads (ovaries in a female; testes in a male).

The aorta ends in the lower abdominal cavity where it branches into 4 main vessels.

- **Internal iliac arteries (R&L)** - inner-most medial branches from the aorta; become the umbilical arteries
  - **Umbilical arteries (R&L)** – continuation of the internal iliac arteries as they change course at the pelvis in order to run along each side of the bladder
  - **Median sacral artery** – thread-like vessel coming off the underside of the aorta between the internal iliac arteries; runs deep toward the sacral region of the spine
- **External iliac arteries (R&L)** - outer lateral branches; branching off these vessels are the **left and right iliolumbars**- which supply blood to the lower portion of the abdominal wall.

Trace the external iliacs into the legs. From here each branches into 2 vessels.

- **Femoral artery**- external branch that continues on down into the leg (femur)
- **Deep femoral artery**- internal branch that goes toward the buttocks and inner thigh.

#### 4. Identify the **veins** that drain the posterior portion of the fetal pig (inferior in humans):

Note: we are tracing the veins in the opposite direction of how blood flows through them. Arteries branch (bifurcate) while veins join together.

- **Inferior vena cava** - large blue vessel running to the right, parallel with the spinal column; drains blood of all structures posterior (inferior) to the heart.
- **Hepatic veins** – drain the sinusoids of the liver; To locate: scrape away some of the liver tissue at the junction of the liver and inferior vena cava.
- **Umbilical vein** – cut previously to allow access to abdomen; reconnect the two halves to see how it brings freshly oxygenated blood through the umbilicus.
- **Hepatic portal vein** – blood “bypass” route from the small intestine into the inferior aspect of the liver.

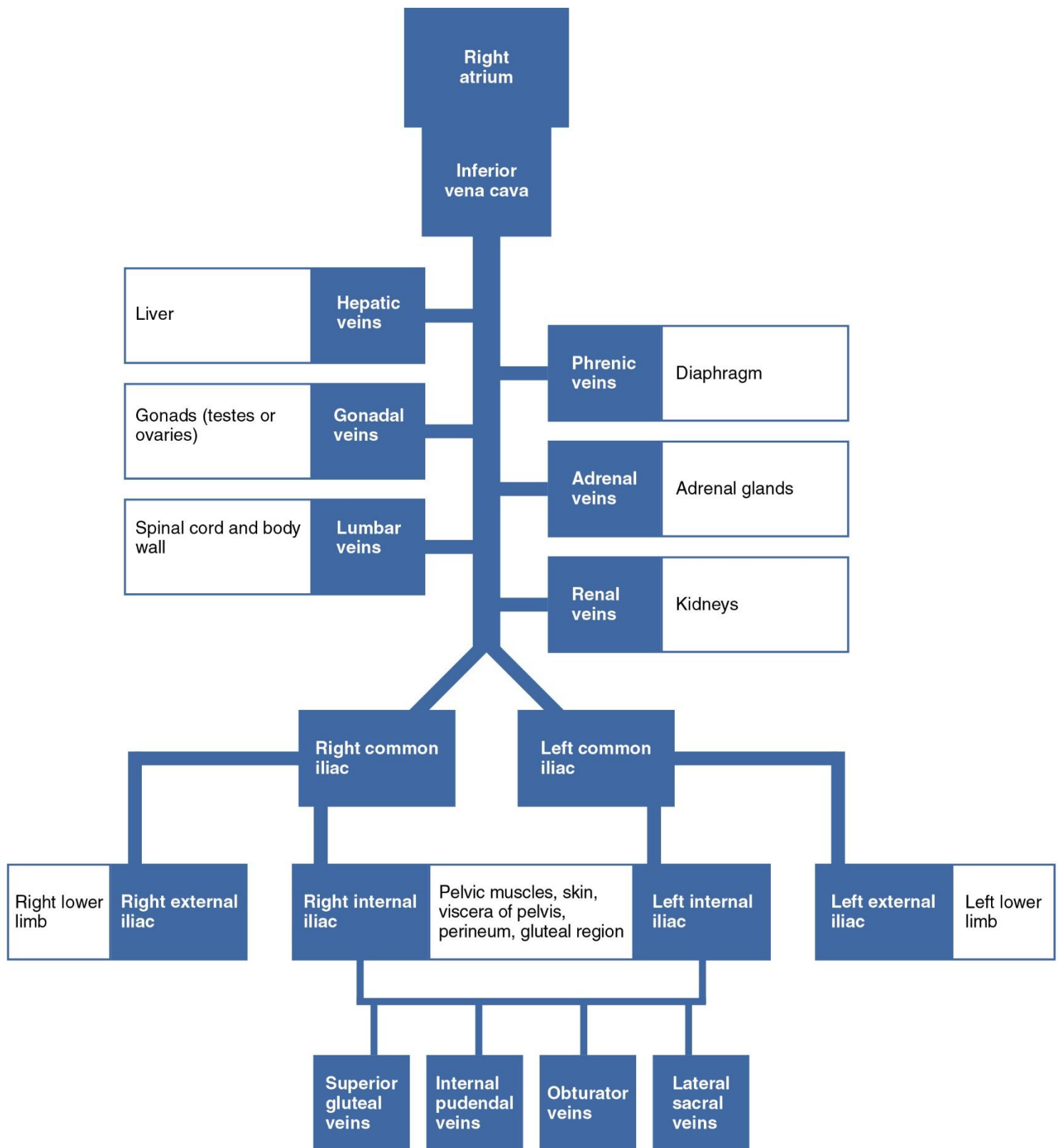
- **Renal vein (R&L)** – exit from the hilum of each kidney

Follow the inferior vena cava down to the base of the abdominal cavity where two major branches join together to form the inferior vena cava.

- **Common iliac veins (R&L)** –the joining of the common iliac veins occurs underneath the aorta- you may have to lift up the aorta to see this junction. The left and right common iliac veins run immediately beneath the *external iliac arteries*.
- **Internal iliac vein (R&L)** – medial branch joining into the common iliac vein; come from deep in the back of the pelvic cavity
- **External iliac vein (R&L)** – lateral branch; comes from the leg where it arises from the femoral & deep femoral veins

## Lab Activity 6.2 Identification and Blood Flow Pathways of Inferior Vessels

Activity 6.2.1 Draw and label your own inferior arterial vessel map in the space provided below. It is recommended that you only identify the vessels which have been indicated on your inferior vessels list

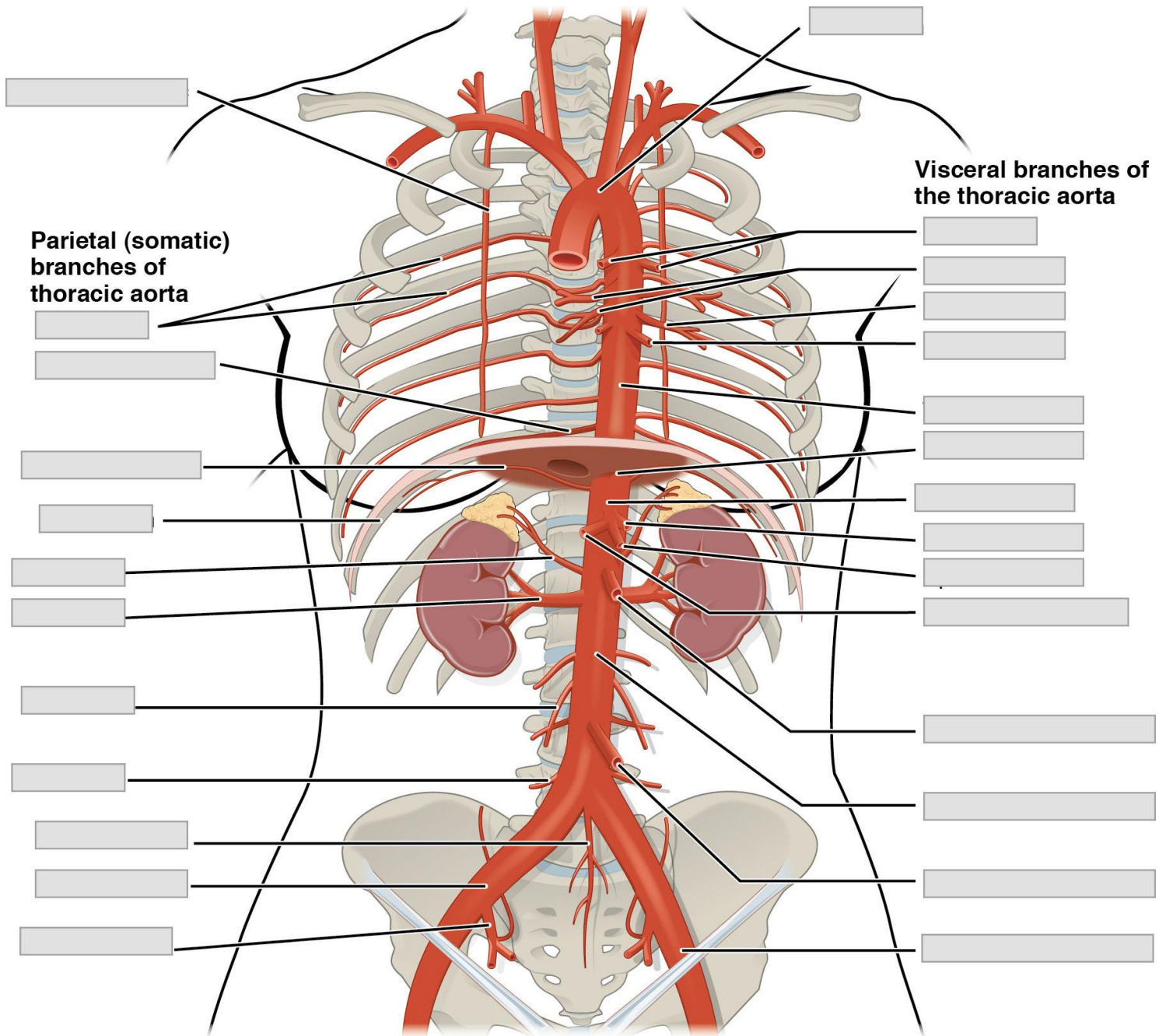




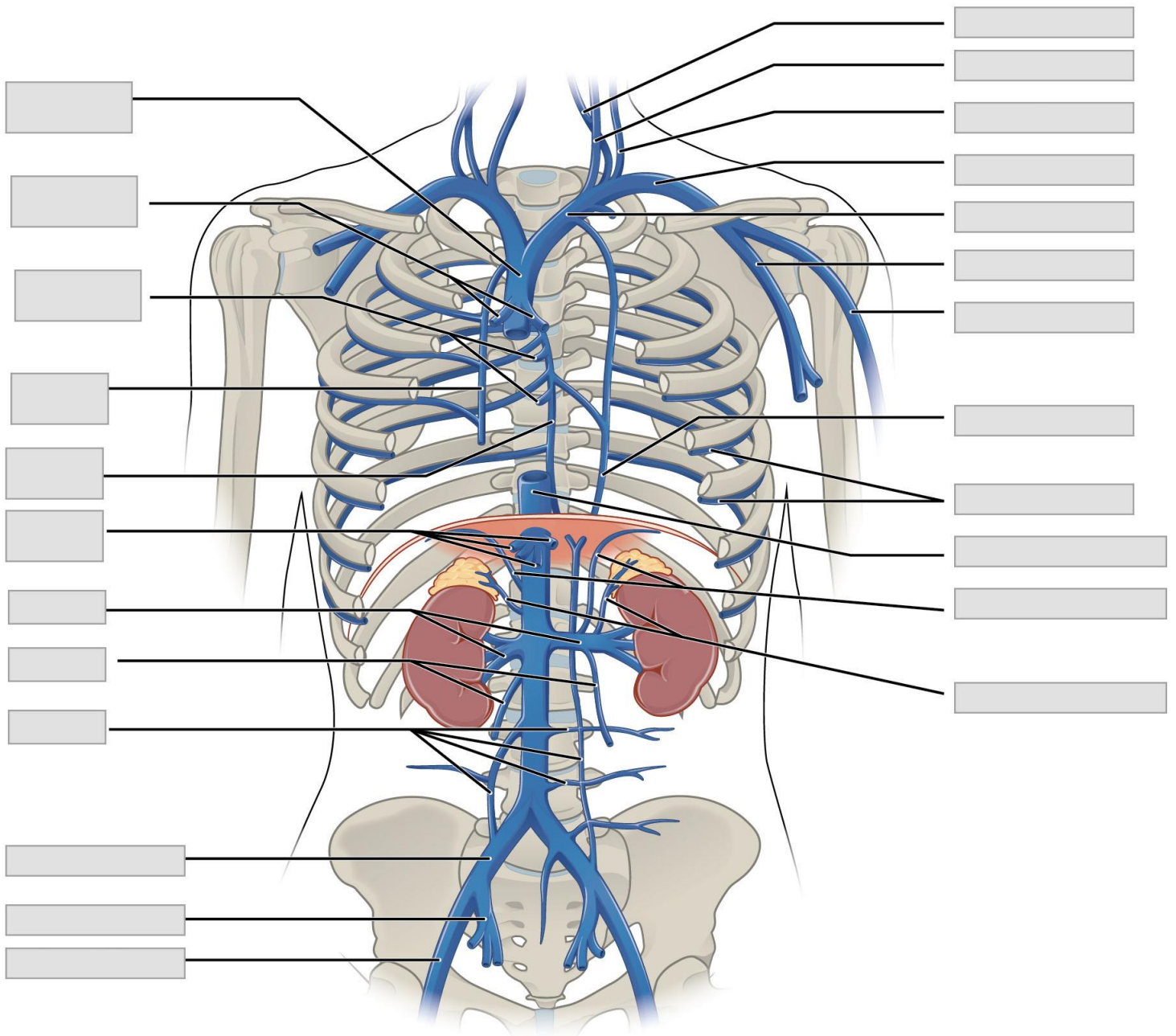
Activity 6.2.2 Draw and label your own inferior venous vessel map in the space provided below. It is recommended that you only identify the vessels which have been indicated on your inferior vessels list

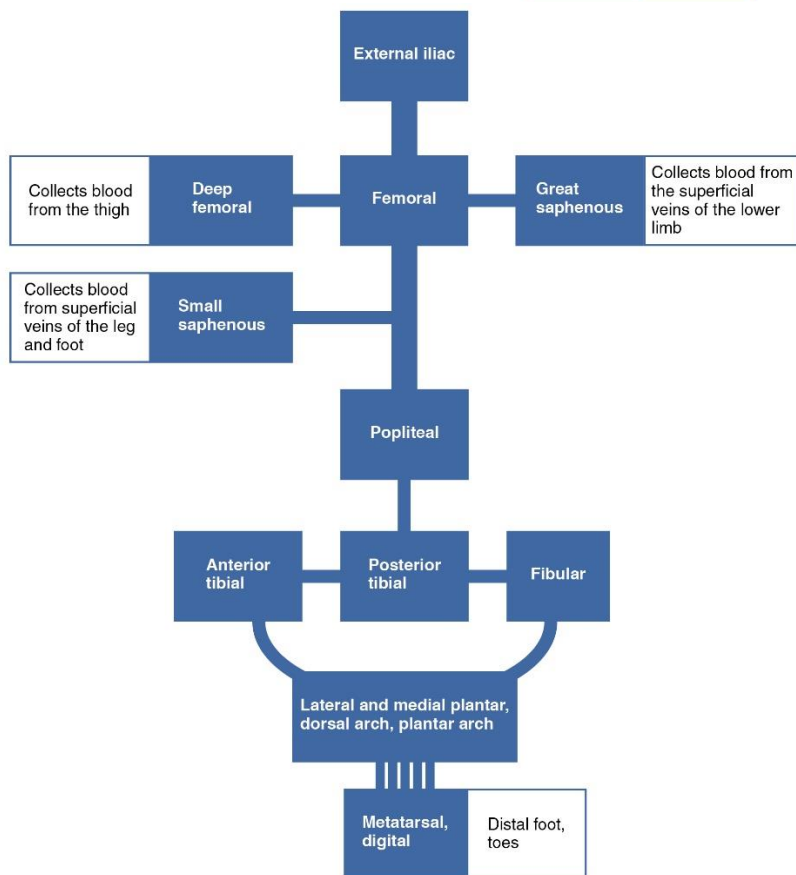
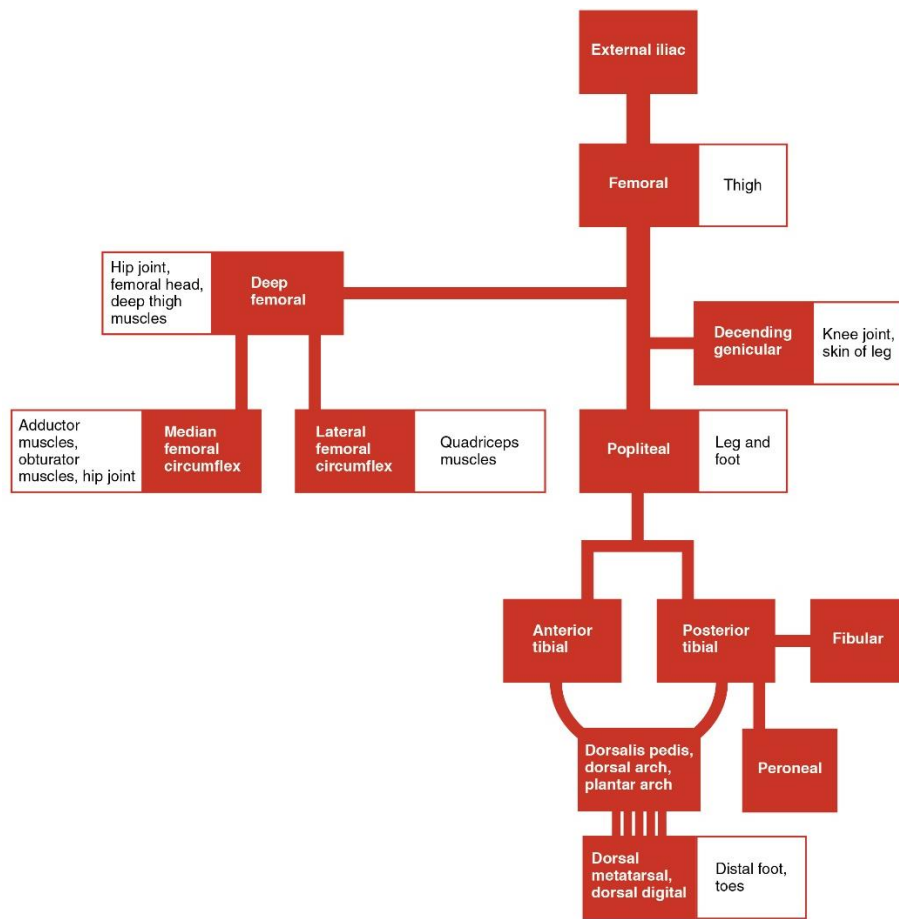
## Lab Activity 6.3

Note: It is recommended that you only identify the vessels in the image below which have been indicated on your inferior vessels list



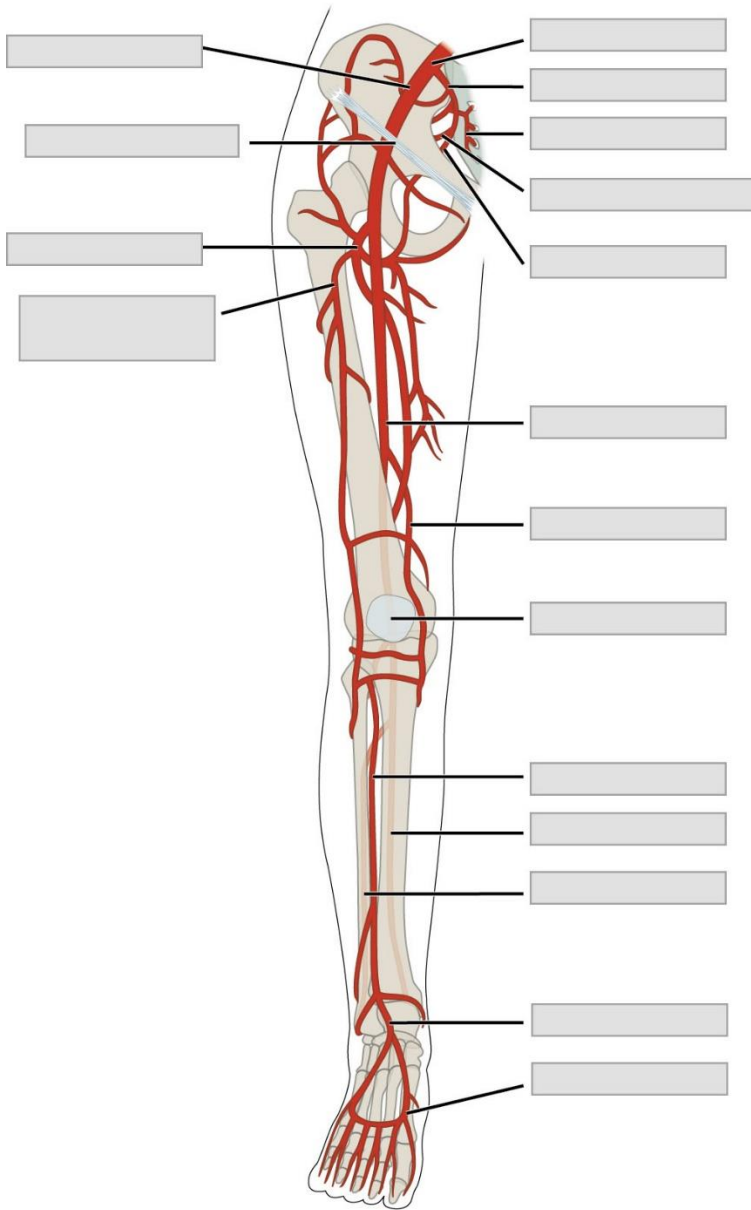
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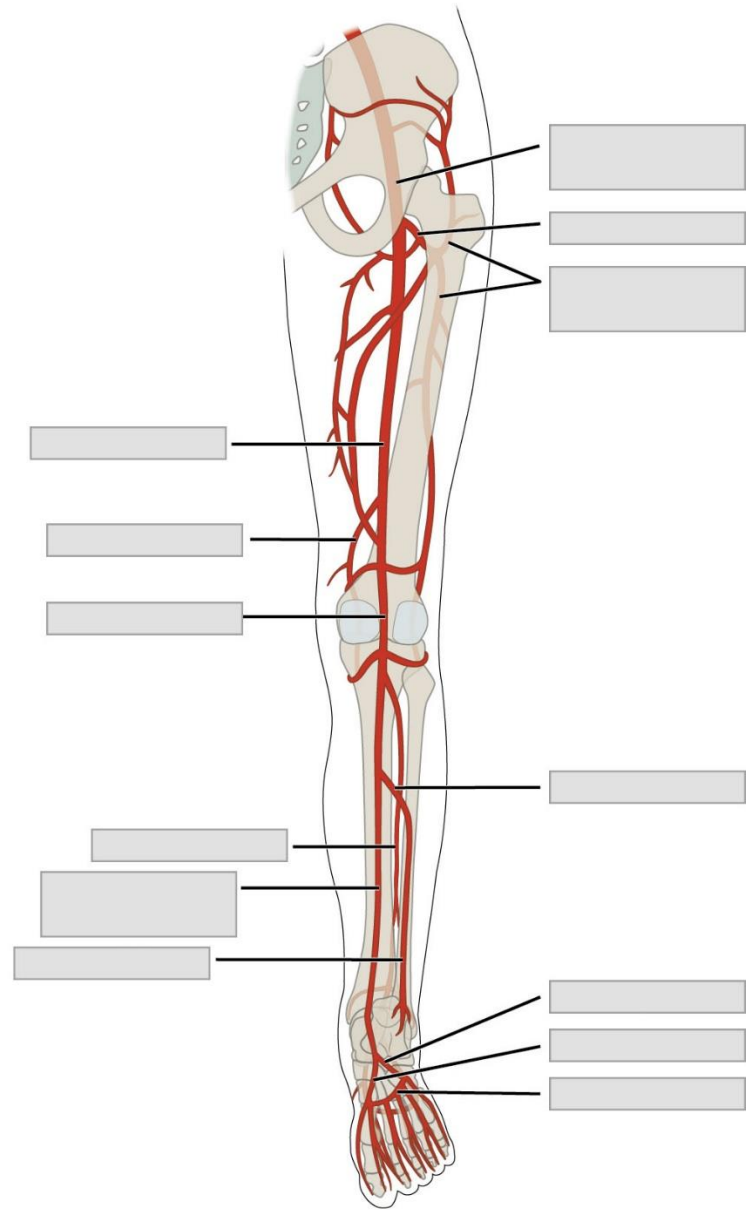




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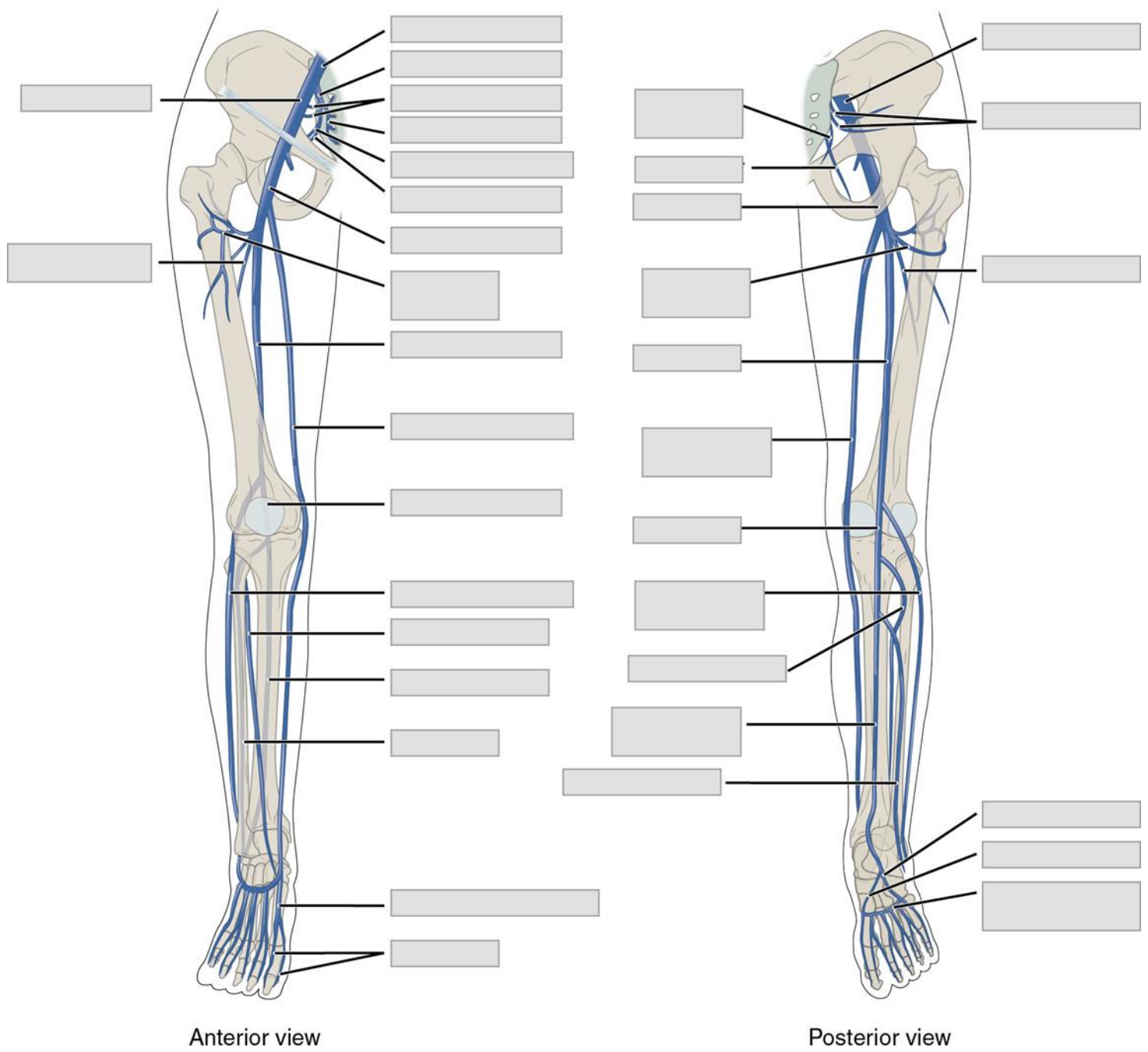


Anterior view



Posterior view

Note: It is recommended that you only identify the vessels in the image below which have been indicated on your inferior vessels list



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