

# Exercise 5: Blood Vessels: Superior

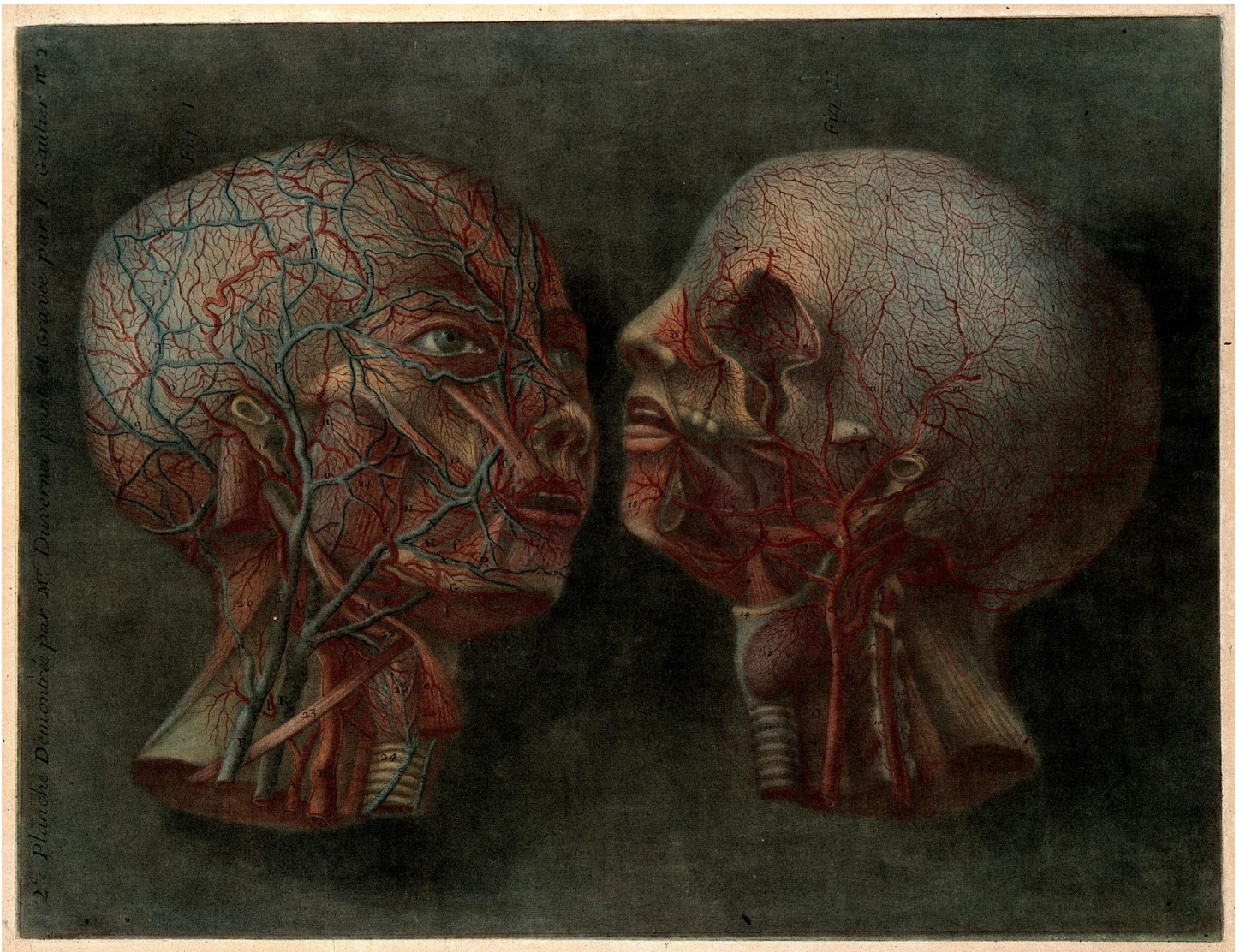


Figure 5.1 : Blood vessels of the head and neck by J. F. Gautier D'Agoty.

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## Exercise 5 Learning Goals

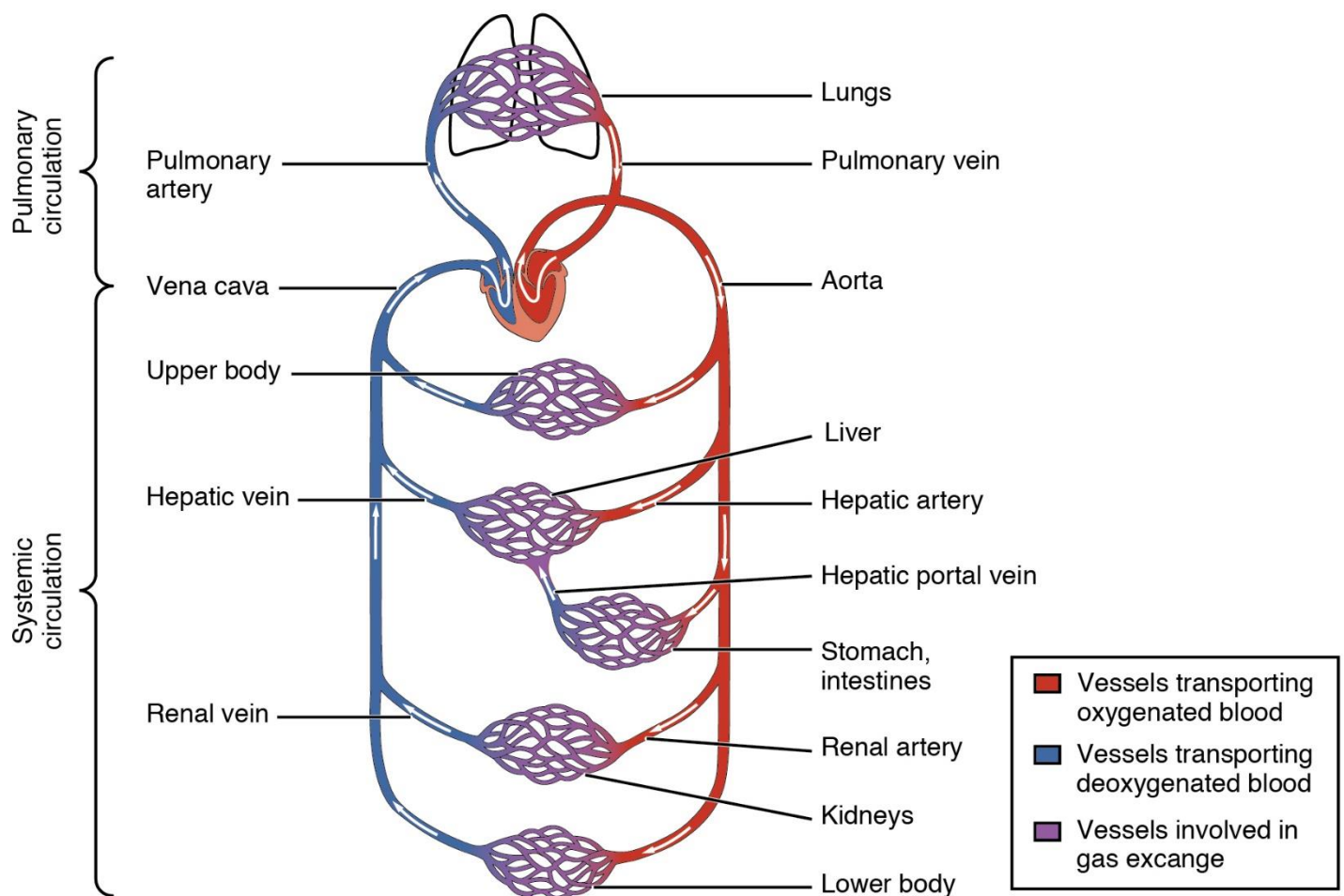
After completing this lab, you should be able to:

- Know and identify the difference in histology of arteries, veins and nerves
- Identify and describe the major arteries and veins of the human upper body
- Gross identification of arteries, veins and nerves from a dissection specimen

## Pre-Lab Activity 5.1:

Blood is carried through the body via blood vessels. An artery is a blood vessel that carries blood away from the heart, where it branches into ever-smaller vessels. Eventually, the smallest arteries, vessels called arterioles, further branch into tiny capillaries, where nutrients and wastes are exchanged, and then combine with other vessels that exit capillaries to form venules, small blood vessels that carry blood to a vein, a larger blood vessel that returns blood to the heart.


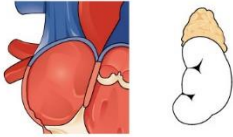


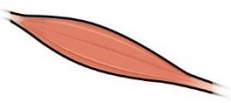

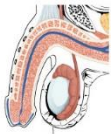


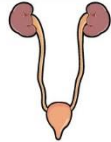
Arteries and veins transport blood in two distinct circuits: the systemic circuit and the pulmonary circuit. Systemic arteries provide blood rich in oxygen to the body's tissues. The blood returned to the heart through systemic veins has less oxygen, since much of the oxygen carried by the arteries has been delivered to the cells. In contrast, in the pulmonary circuit, arteries carry blood low in oxygen exclusively to the lungs for gas exchange. Pulmonary veins then return freshly oxygenated blood from the lungs to the heart to be pumped back out into systemic circulation. Although arteries and veins differ structurally and functionally, they share certain features.



Pre 5.1.Critical Thinking: Identify the structures in the body where capillary beds are found. What physiological processes occur in capillaries? Why do some single organs have such high concentrations of capillaries within their tissues?



Pre 5.1.2 Complete the following table on the role of the circulatory system in the functioning of other organs and systems.

System	Role of Circulatory System
Digestive 	
Endocrine 	
Integumentary 	
Lymphatic 	
Muscular 	
Nervous 	
Reproductive 	
Respiratory 	
Skeletal 	
Urinary 	

## Pre-Lab Activity 5.2

Different types of blood vessels vary slightly in their structures, but they share the same general features. Arteries and arterioles have thicker walls than veins and venules because they are closer to the heart and receive blood that is surging at a far greater pressure. Each type of vessel has a **lumen**—a hollow passageway through which blood flows. Arteries have smaller lumens than veins, a characteristic that helps to maintain the pressure of blood moving through

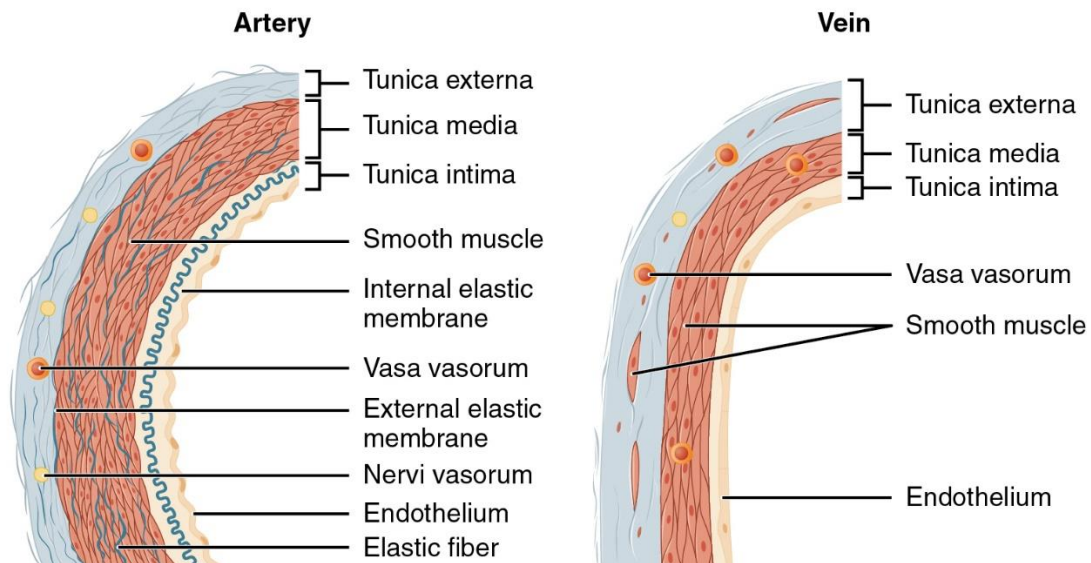
the system. Together, their thicker walls and smaller diameters give arterial lumens a more rounded appearance in cross section than the lumens of veins.

By the time blood has passed through capillaries and entered venules, the pressure initially exerted upon it by heart contractions has diminished. In other words, in comparison to arteries, venules and veins withstand a much lower pressure from the blood that flows through them. Their walls are considerably thinner and their lumens are correspondingly larger in diameter, allowing more blood to flow with less vessel resistance. In addition, many veins of the body, particularly those of the limbs, contain valves that assist the unidirectional flow of blood toward the heart. This is critical because blood flow becomes sluggish in the extremities, as a result of the lower pressure and the effects of gravity.



The walls of arteries and veins are largely composed of living cells and their products (including collagenous and elastic fibers); the cells require nourishment and produce waste. Since blood passes through the larger vessels relatively quickly, there is limited opportunity for blood in the lumen of the vessel to provide nourishment to or remove waste from the vessel's cells. Further, the walls of the larger vessels are too thick for nutrients to diffuse through to all of the cells. Larger arteries and veins contain small blood vessels within their walls known as the **vasa vasorum**—literally “vessels of the vessel”—to provide them with this critical exchange. Since the pressure within arteries is relatively high, the vasa vasorum must function in the outer layers of the vessel or the pressure exerted by the blood passing through the vessel would collapse it, preventing any exchange from occurring. The lower pressure within veins allows the vasa vasorum to be located closer to the lumen. The restriction of the vasa vasorum to the outer layers of arteries is thought to be one reason that arterial diseases are more common than venous diseases, since its location makes it more difficult to nourish the cells of the arteries and remove waste products. There are also minute nerves within the walls of both types of vessels that control the contraction and dilation of smooth muscle. These minute nerves are known as the **nervi vasorum**.

Both arteries and veins have the same three distinct tissue layers, called tunics (from the Latin term tunica).



### Pre 5.2.2 Comparison of Tunics in Arteries and Veins

Complete the table listing the features of and structures present/absent in arteries and veins.

	Arteries	Veins
<b>General appearance</b>	Thick walls with small lumens Generally appear rounded	
<b>Tunica intima</b>	<b>Tissues:</b> Endothelium usually appears wavy due to constriction of smooth muscle <b>Structures:</b> Internal elastic membrane present in larger vessels	<b>Tissues:</b> Endothelium appears smooth <b>Structures:</b> Internal elastic membrane absent
	Normally the thickest layer in arteries <b>Tissues:</b> <b>Structures:</b>	Normally thinner than the tunica externa <b>Tissues:</b> <b>Structures:</b>
	<b>Tissues:</b> <b>Structures:</b>	Normally the thickest layer in veins <b>Tissues:</b> <b>Structures:</b>

## Lab 5 Activities

### Structures to Identify:

#### Arteries:

- Aorta – regions: ascending, arch, descending, thoracic
- Pulmonary trunk → Pulmonary artery (R&L)
- Ductus arteriosus
- Coronary arteries (surface of heart)
- Brachiocephalic artery
- Common carotid artery (R&L)
- Subclavian artery (R&L)
- Axillary artery (R&L)
- Internal mammary (thoracic) artery (R&L)
- Intercostal arteries (R-side/L-side)

#### Veins:

- Superior & Inferior vena cava
- Coronary veins (surface of heart)
- Hemiazygous vein (L side only)
- Internal jugular vein (R&L)
- External jugular vein (R&L)
- Brachiocephalic vein (R&L)
- Subclavian vein (R&L)
- Axillary vein (R&L)
- Subscapular vein (R&L)
- Cephalic vein (R&L)
- Intercostal veins (R-side/L-side)

## Lab Activity 5.1 Fetal Pig Dissection

Supplies needed: Gloves, scalpel, blunt probe, tweezers

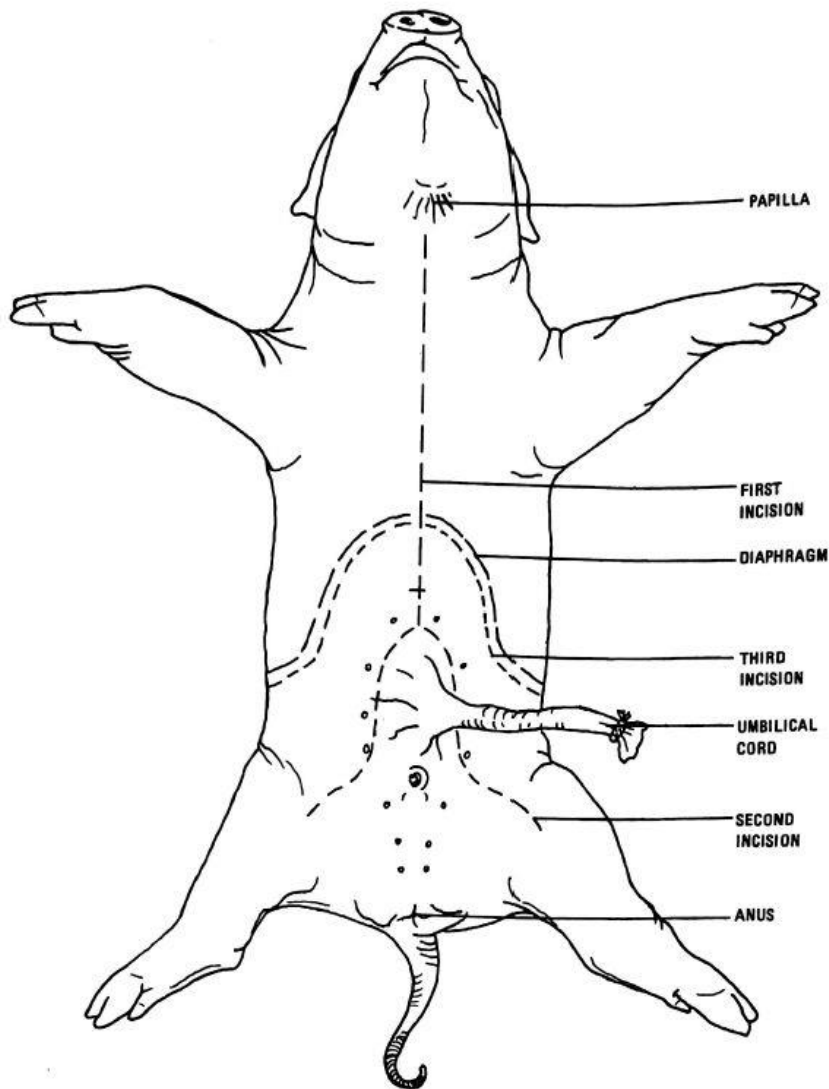
For the **ANTERIOR** portion of the fetal pig circulatory system:

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

1. Open the body cavity. You can often “begin” a cut using your scalpel then switch to scissors.
  - To begin- make two incisions through the skin of the abdomen so that each one goes around one side of the umbilical cord and each extends down to the beginning of the legs. Be careful that you are only cutting through the abdominal wall- if you cut too deeply the underlying organs will be destroyed. We need them for future dissections!
  - Make a **lateral** incision at the base of the rib cage. This should be as close as possible to where the diaphragm separates the thoracic and abdominal cavities. Extend this cut to both the right and left sides by using the inferior edge of the ribcage as a guide.
  - Finally, make an incision beginning at the papilla on the underside of the chin and extending down to the base of the sternum.
    - In the first step, cut through the skin of the thoracic cavity, but DO NOT cut into the sternum. Peel the skin back away from the rib cage. This will allow you to see more clearly where the sternum is before you cut it open.
    - Ideally, you will cut the sternum directly down the middle to open the thoracic cavity. Be careful that you do not cut too deeply and damage the heart or the blood vessels coming out of the heart. To avoid this, take your blunt probe and run it up underneath the sternum. You can then use your scalpel to cut down to the probe without damaging any important structures. If the



mid-line cut does not seem to be working well, cut through the costal cartilages immediately to the right or left of the sternum. Cutting too far away from the sternum will destroy vessels you need to see.



2. Once the thoracic cavity is opened, put away your scalpel. Everything else can be accomplished with the blunt probe, tweezers, and your gloved hands. The first thing you will need to do is clean out the connective tissue on each side of the throat. The blood vessels you are looking for are **deep** in the body cavity here and so the overlying tissue must be removed. The majority of this tissue is the **thymus**, an important endocrine gland, which sits on each side of the throat and over the front of the heart. You will need to remove all of the pebble-looking thymus tissue.

○ Remove only connective tissues on both sides of the throat. **DO NOT** move the structures in the middle of the throat- these are parts of the respiratory system (larynx and trachea) and the **thyroid gland**. The thyroid is superficial to the trachea, just superior to the heart.

3. After you have removed the thymus and outer masses of connective tissue, there may still be considerable connective tissue around the blood vessels. Use your **first incision** tweezers to clean off the vessels so that you can trace them from the heart out into the body.

4. Identify the **arteries** that supply the anterior portion of the fetal pig (superior in humans) :

- **Pulmonary trunk** - connects with the right ventricle (just as it did in the sheep heart).
- **Aorta** - lies immediately behind the pulmonary

artery. The aorta is divided into different sections: the **ascending aorta** is the small section where it leaves the heart, the **aortic arch** is where it arches over the heart, and the **descending aorta** is that portion that goes down along the spinal column from the heart. Once it clears the heart it becomes the **thoracic aorta** and then after passing through the diaphragm, it is the **abdominal aorta**.

- **Ductus arteriosus**- follow the pulmonary artery from where it leaves the heart until you see a small branch connecting to the aorta. Notice that one branch of the pulmonary artery connects it with the aorta- this is the ductus arteriosus. The other branch of the pulmonary trunk splits to become the **right and left pulmonary arteries**.
- **Coronary arteries** – oxygenated vessels on the surface of the heart. If you look closely, you should be able to see where the left and right coronary arteries branch off the ascending aorta.
- **Brachiocephalic artery** – first major branch that comes off the aortic arch. The brachiocephalic artery travels underneath the superior vena cava and branches into the 1) **right subclavian artery** - which goes into the right front leg, and the 2) **right & left common carotid arteries** - which supply the head.
- **Left subclavian artery** – second major branch off the aortic arch; supplies the left front leg.

- **Internal mammary arteries (R&L)** – branch immediately off the subclavians; run parallel down the internal surface of the ribcage, following the nipple line.
- **Axillary arteries (R&L)** – continuation of the subclavians as they move into the front limbs; will become the brachial arteries as they continue down the humerus
- **Intercostal arteries** – run parallel to and supply the tissue along each rib.

Remember: Immediately below each rib is a **V-A-N**

V- intercostal vein, A- intercostal artery, N- intercostal nerve

5. Identify the **veins** that drain the anterior portion of the fetal pig (superior 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.

Thoracic/Upper Limbs:

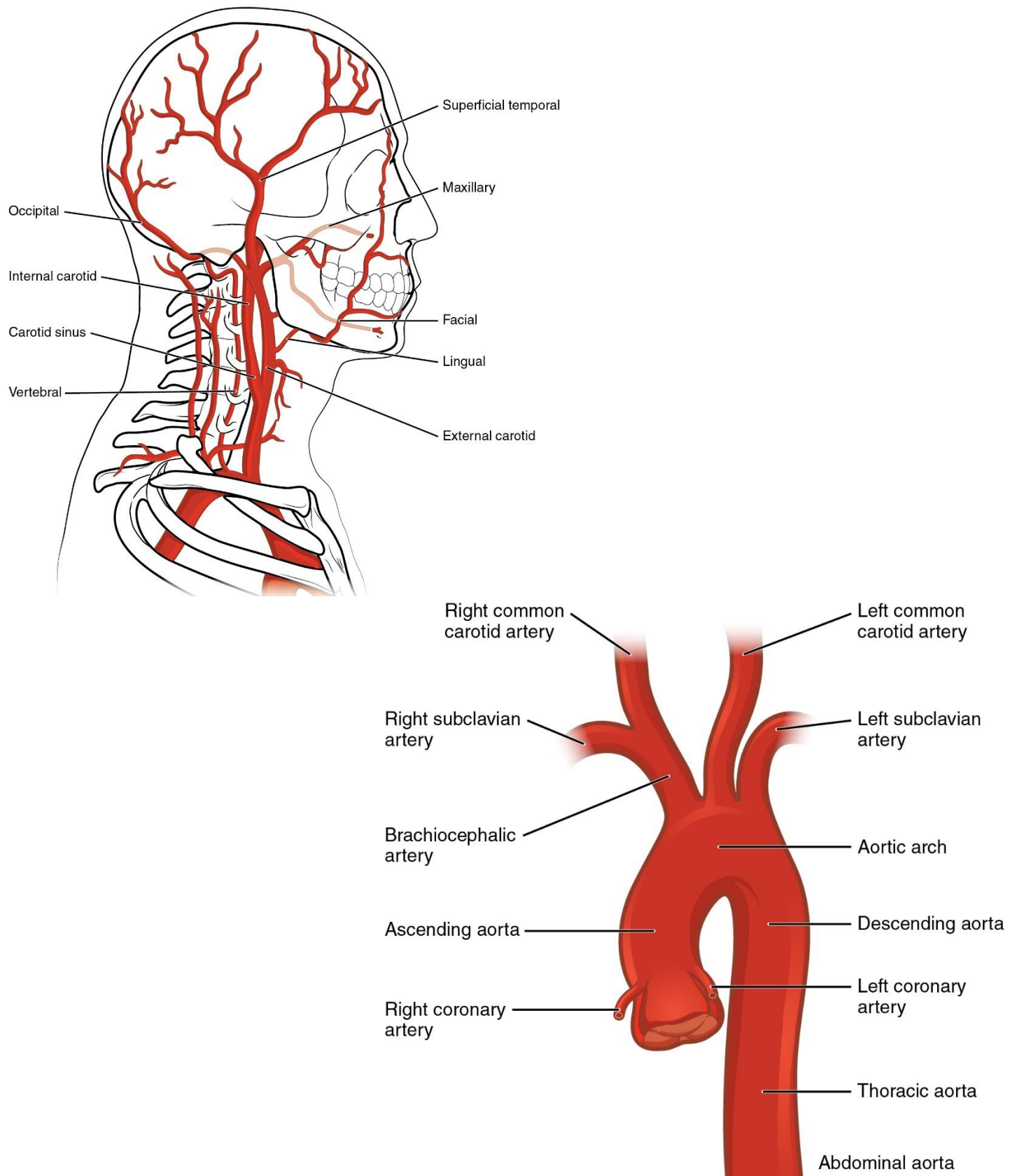
- **Superior vena cava** - large vessel entering the heart from above; just above the right auricle.
- **Inferior vena cava** - large blue vessel entering the heart from below; just above the coronary sulcus where the posterior interventricular sulcus ends.
- **Brachiocephalic veins (R&L)** – To locate: follow the superior vena cava out from the heart and identify the two short branches which join to form it.
- **Subclavian veins (R&L)** – the large vessels which continue to form the brachiocephalic veins; come from the direction of each upper limb.
- **Axillary veins (R&L)** – formed by the joining of many veins in the at the shoulder; continues as the subclavians at the lateral margin of the 1<sup>st</sup> rib
- **Subscapular veins (R&L)** –contributing vessel to the axillary vein; typically small and runs from humeral head.
- **Cephalic veins (R&L)** – large contributing vessel to the axillary vein; comes superficially out of the limbs from the ventral (anterior) surface headed deep
- **Internal mammary veins (R&L)** – drain into the superior vena cava; run along the internal surface of the sternum.
- **Coronary veins** – deoxygenated vessels on the surface of the heart; drain into the coronary sinus
- **Intercostal veins (R&L)** – run parallel to and drain the tissue along each rib. Remember: V-A-N
- **Hemiazygous vein (L only)** - receives blood from the left intercostal veins and lies underneath the descending aorta next to the spinal column. This vessel is left-sided only. There is no right-side version.

Head/Neck:

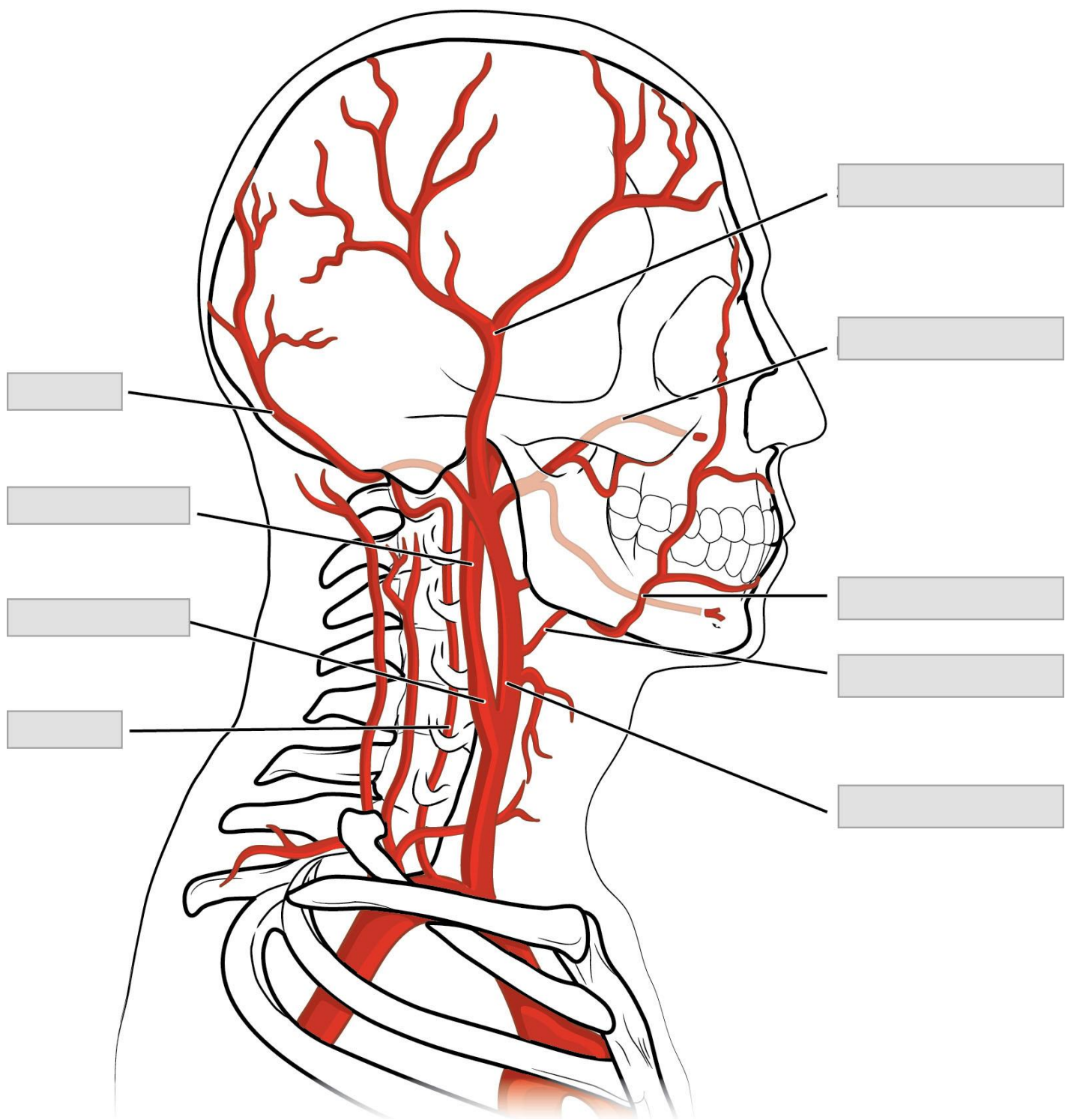
- **Internal jugular veins (R&L)** - closest to the midline on either side of the trachea; typically “bundled” with the carotid arteries and vagus nerves
- **External jugular veins (R&L)** – lateral to the internal jugulars; imagine the midline as 12 on a clock face- the externals run down from 2 (left) and 10 (right). Typically the right external jugular is used as the site of latex injection so it is typically cut and tied with string.



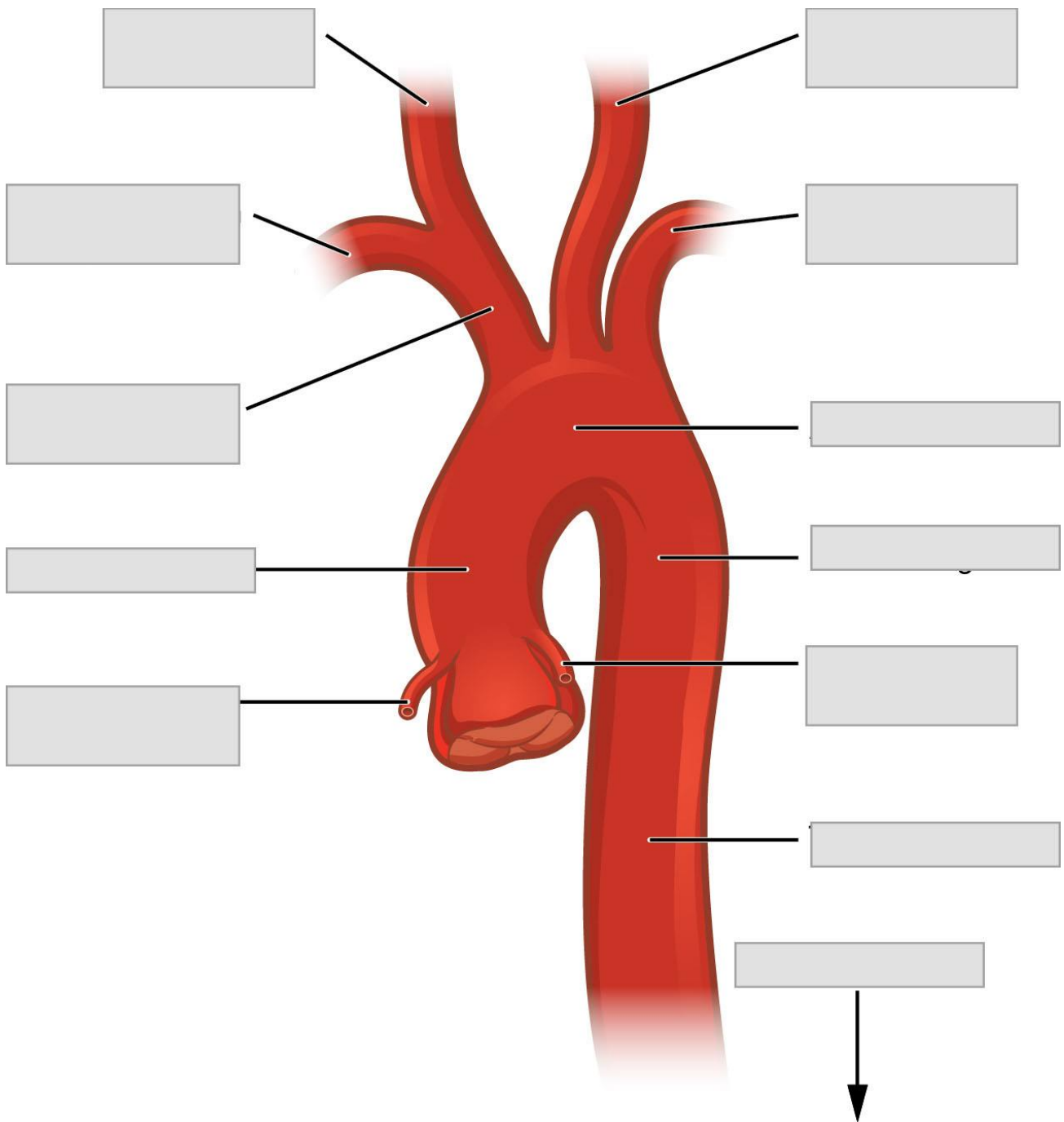
## Lab Activity 5.2 Identification and Blood Flow Pathways of Superior Arteries



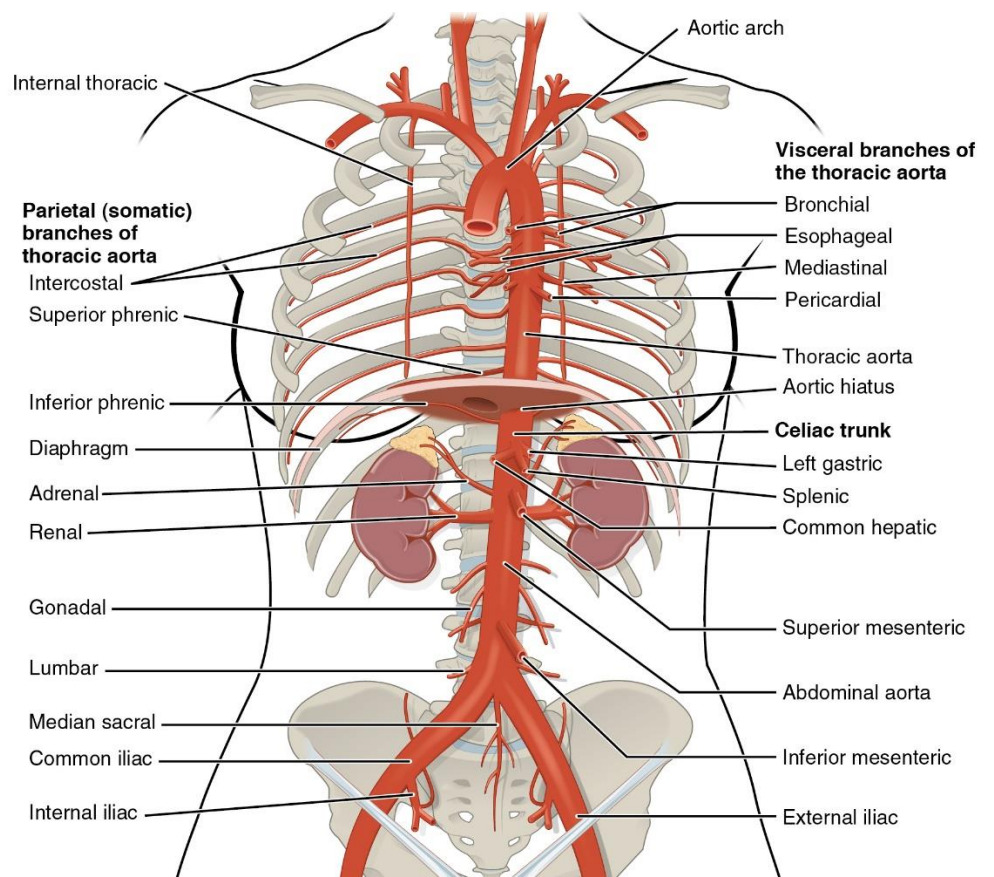
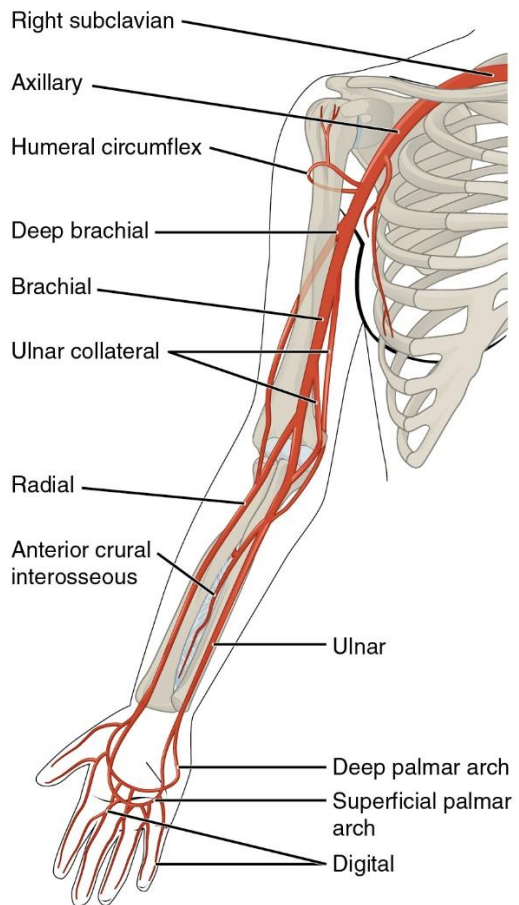
Note: It is recommended that you only identify the vessels in the image below which have been indicated on your superior vessels list



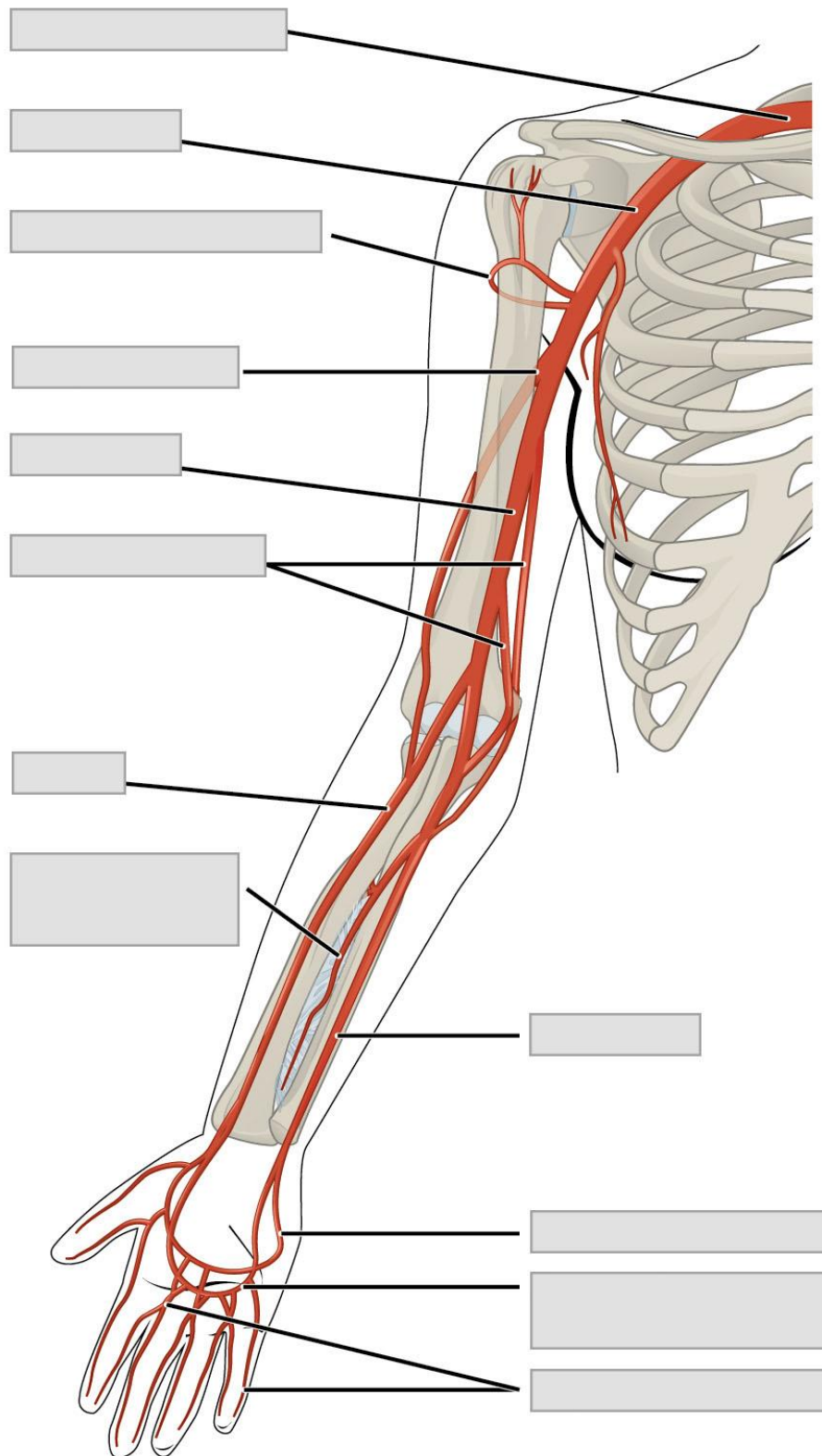
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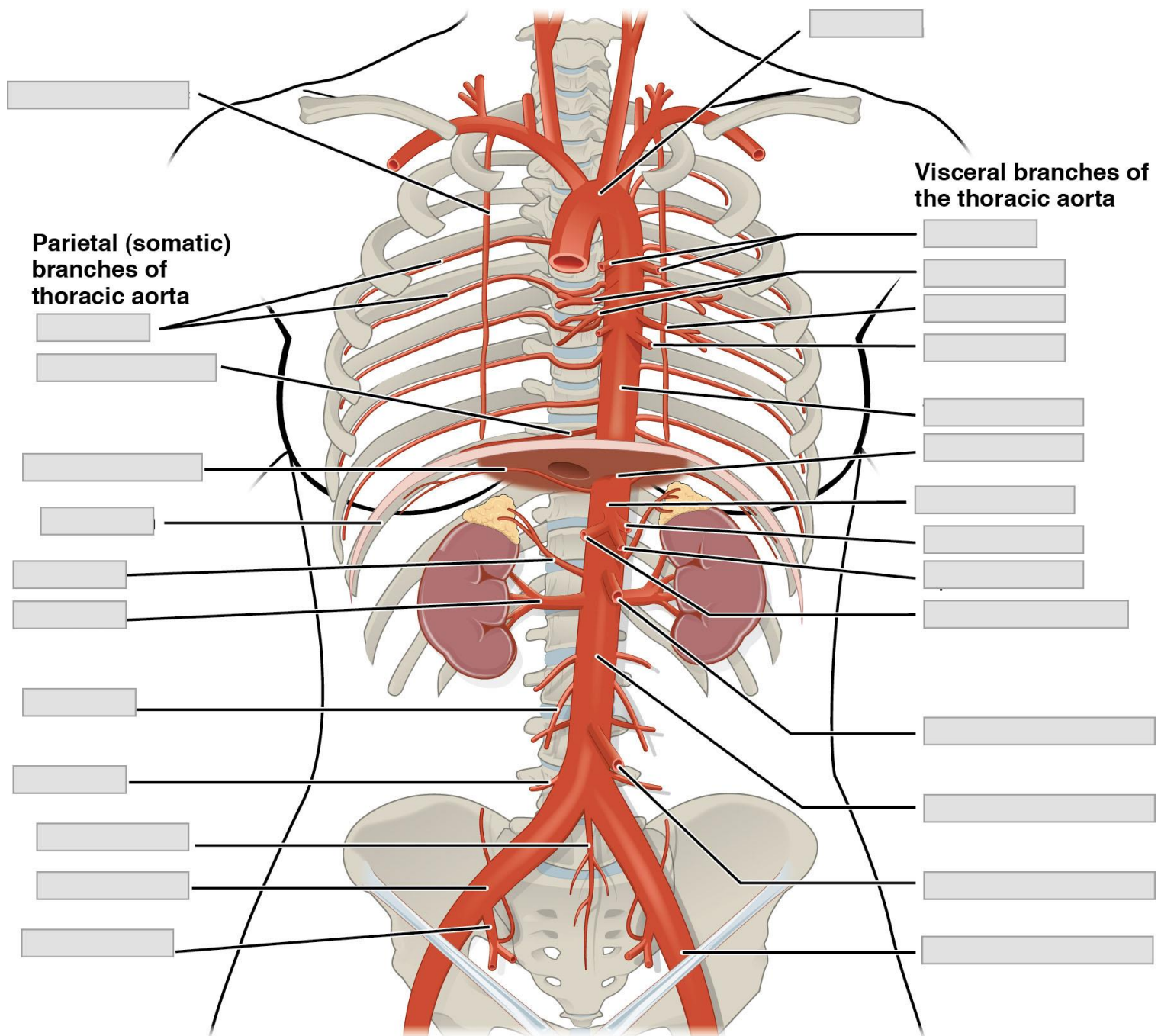




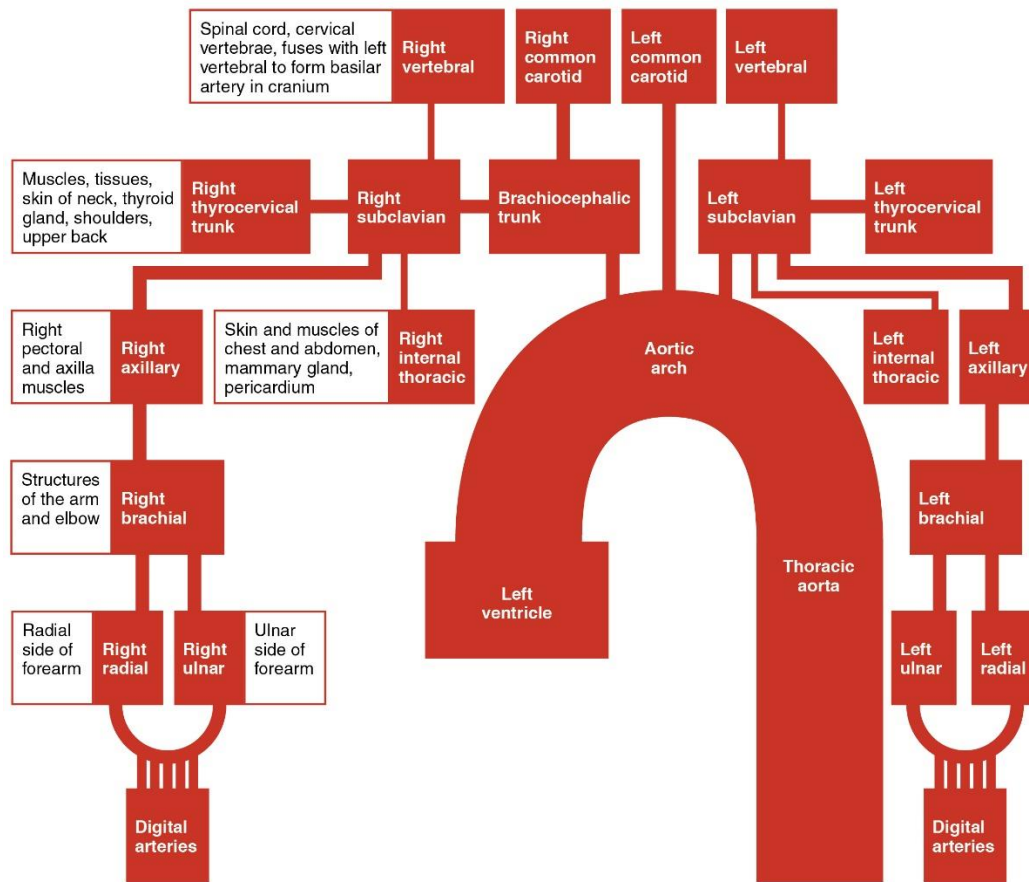
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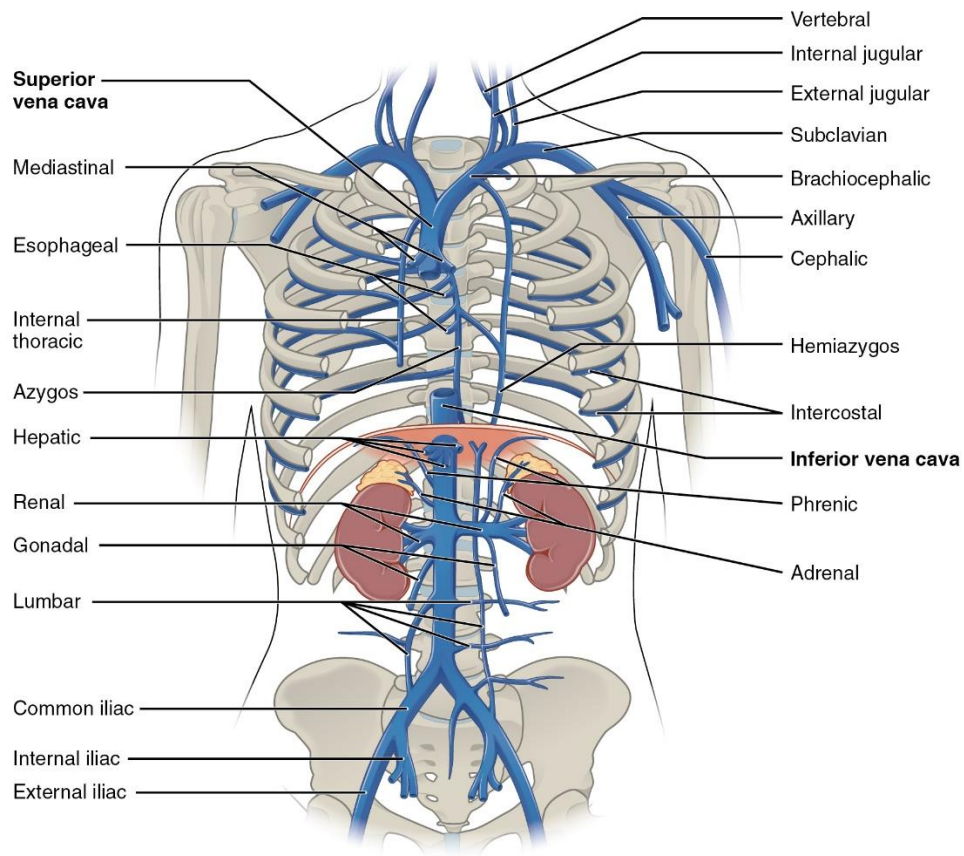
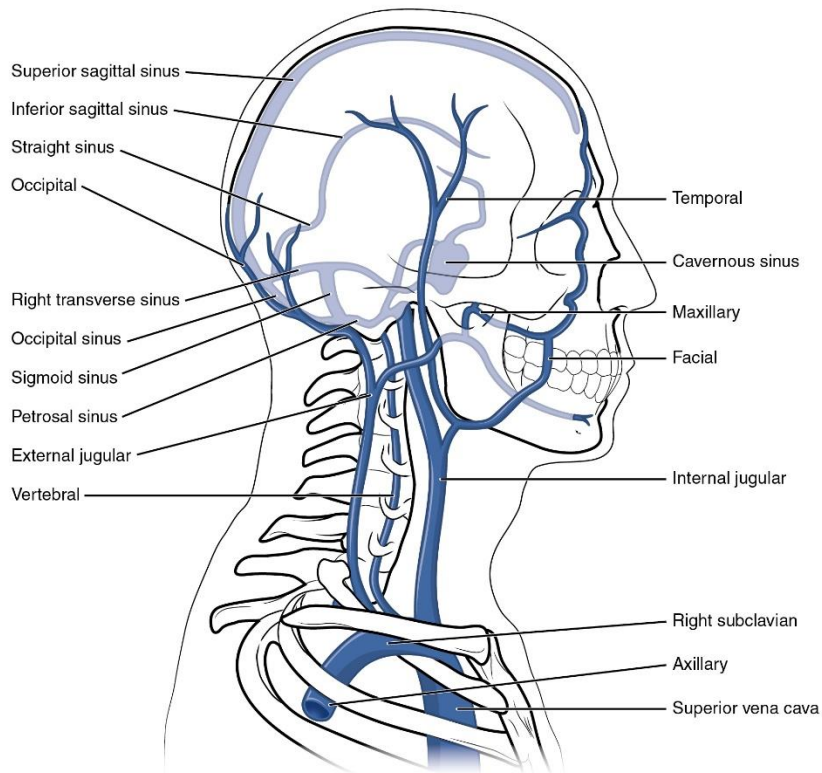




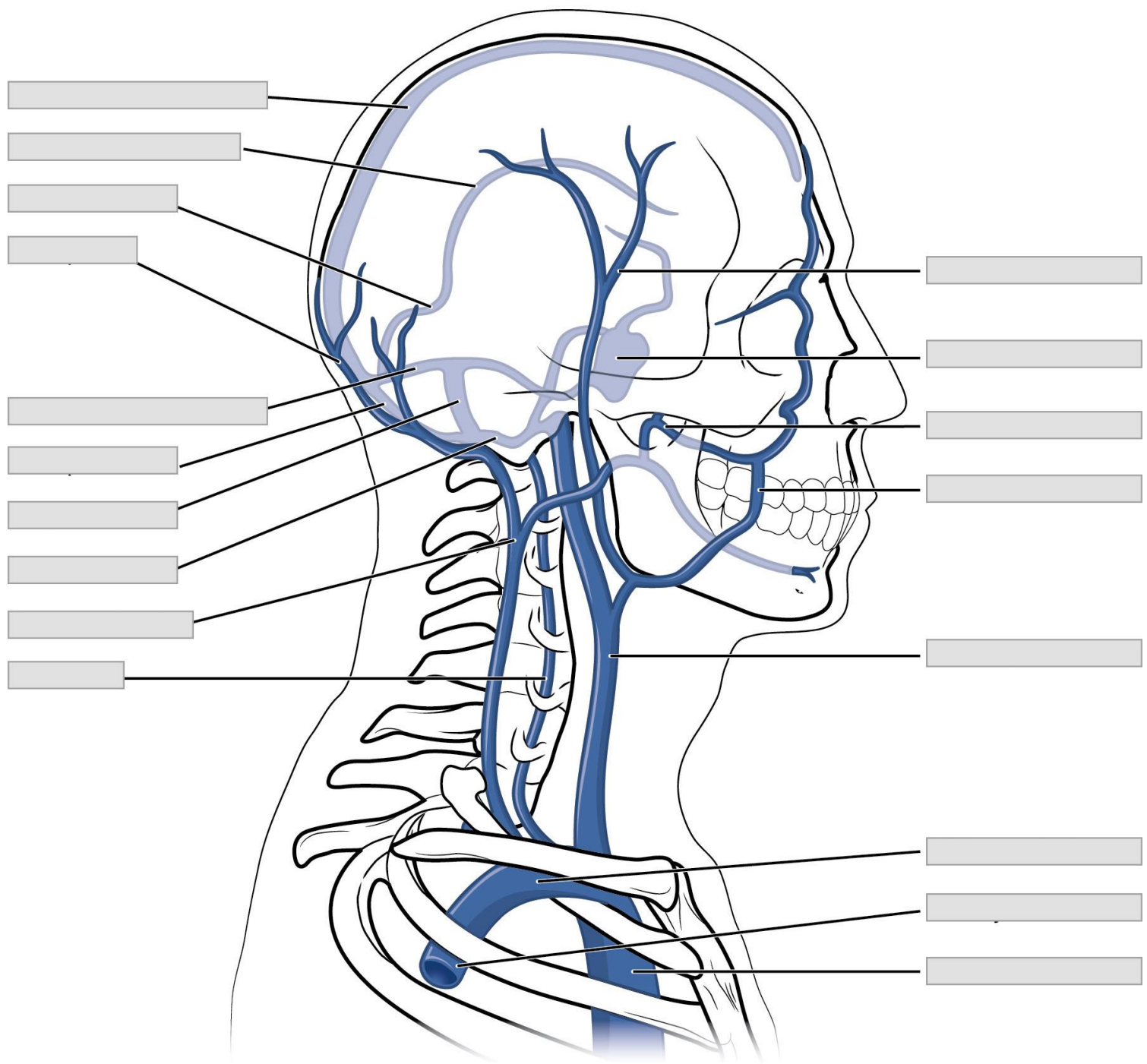


Activity 5.2.2 Draw and label your own superior arterial vessel map in the space provided below. It is recommended that you only identify the vessels which have been indicated on your superior vessels list

## Lab Activity 5.3 Identification and Blood Flow Pathways of Superior Veins

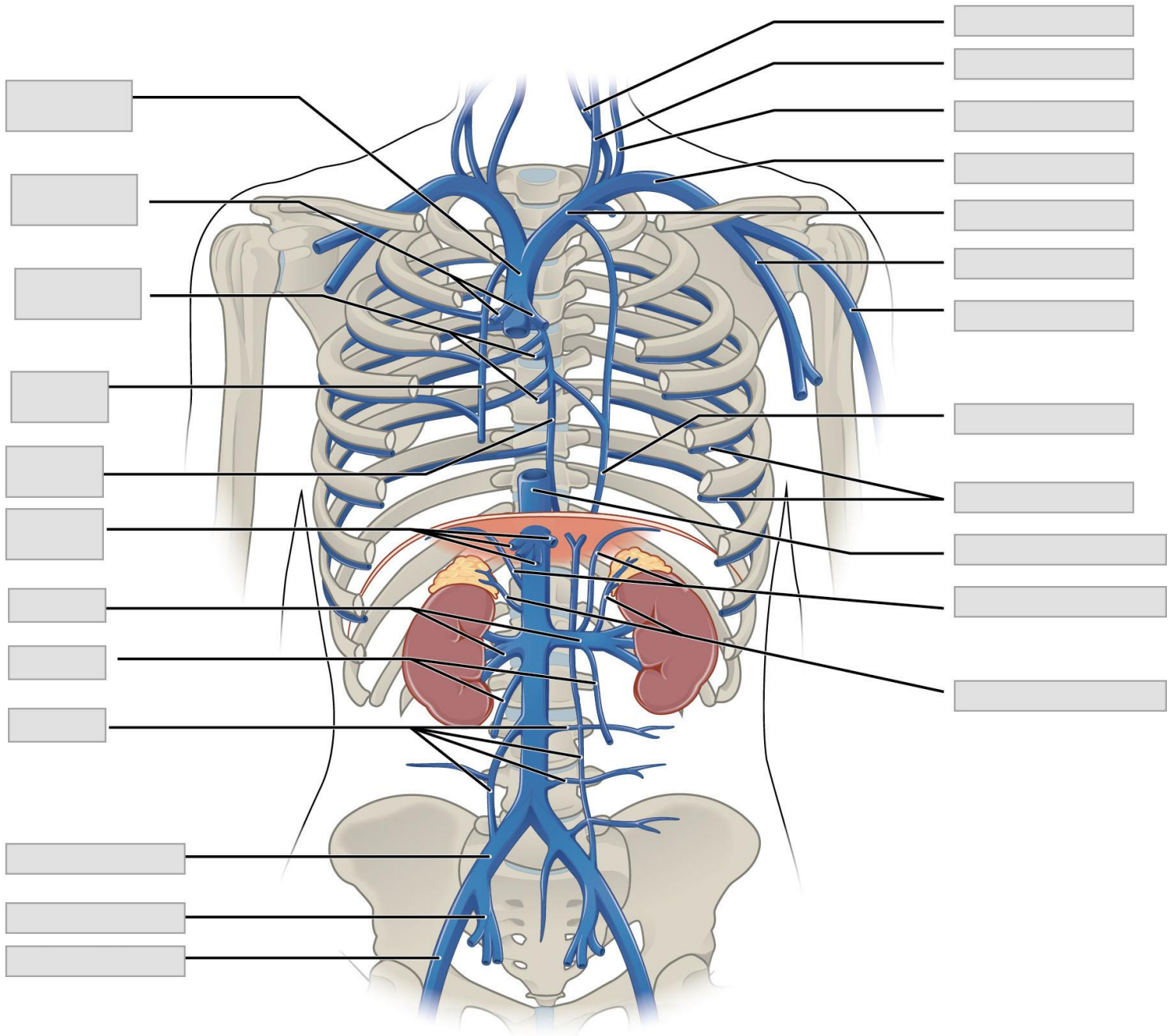


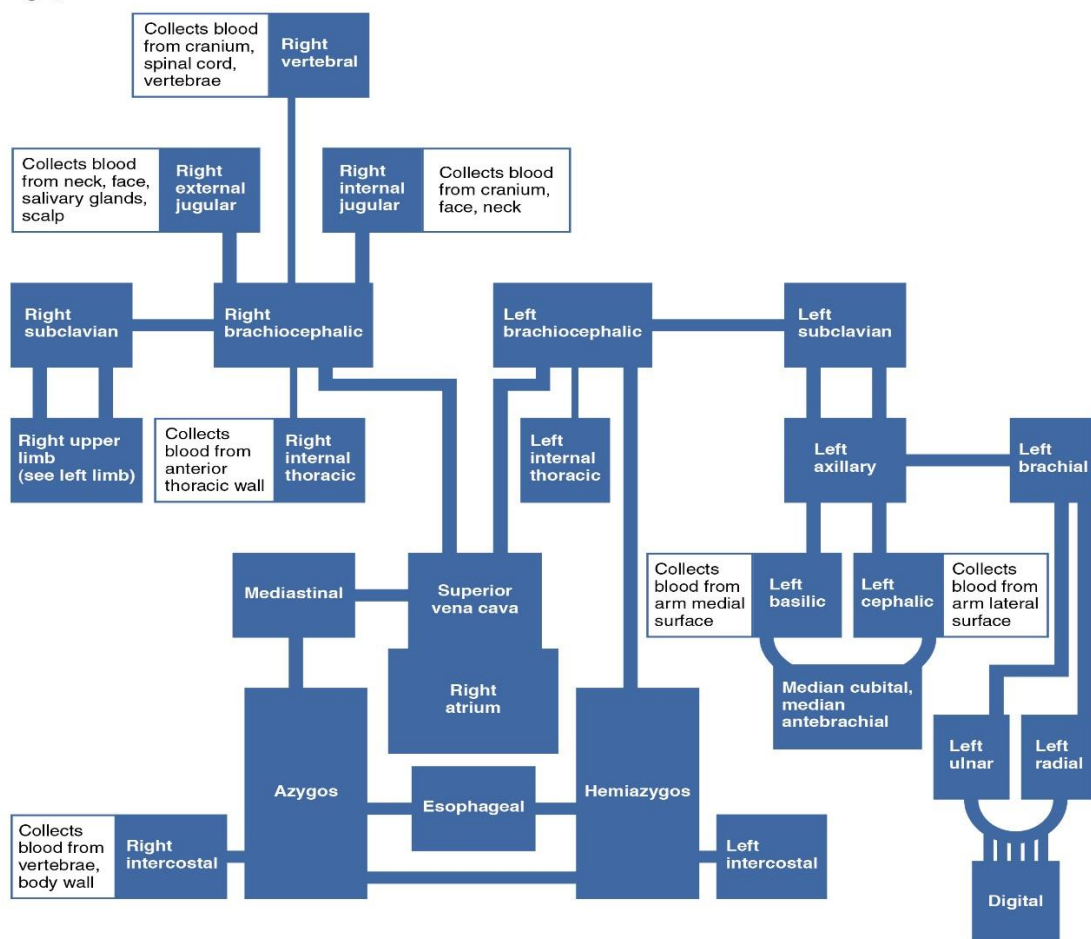
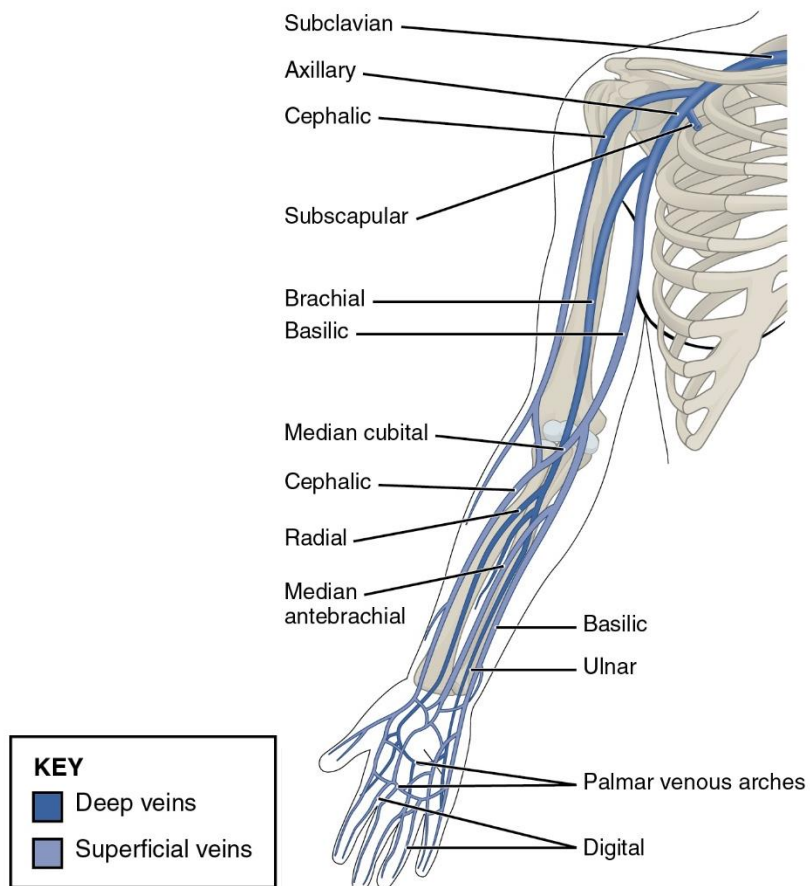
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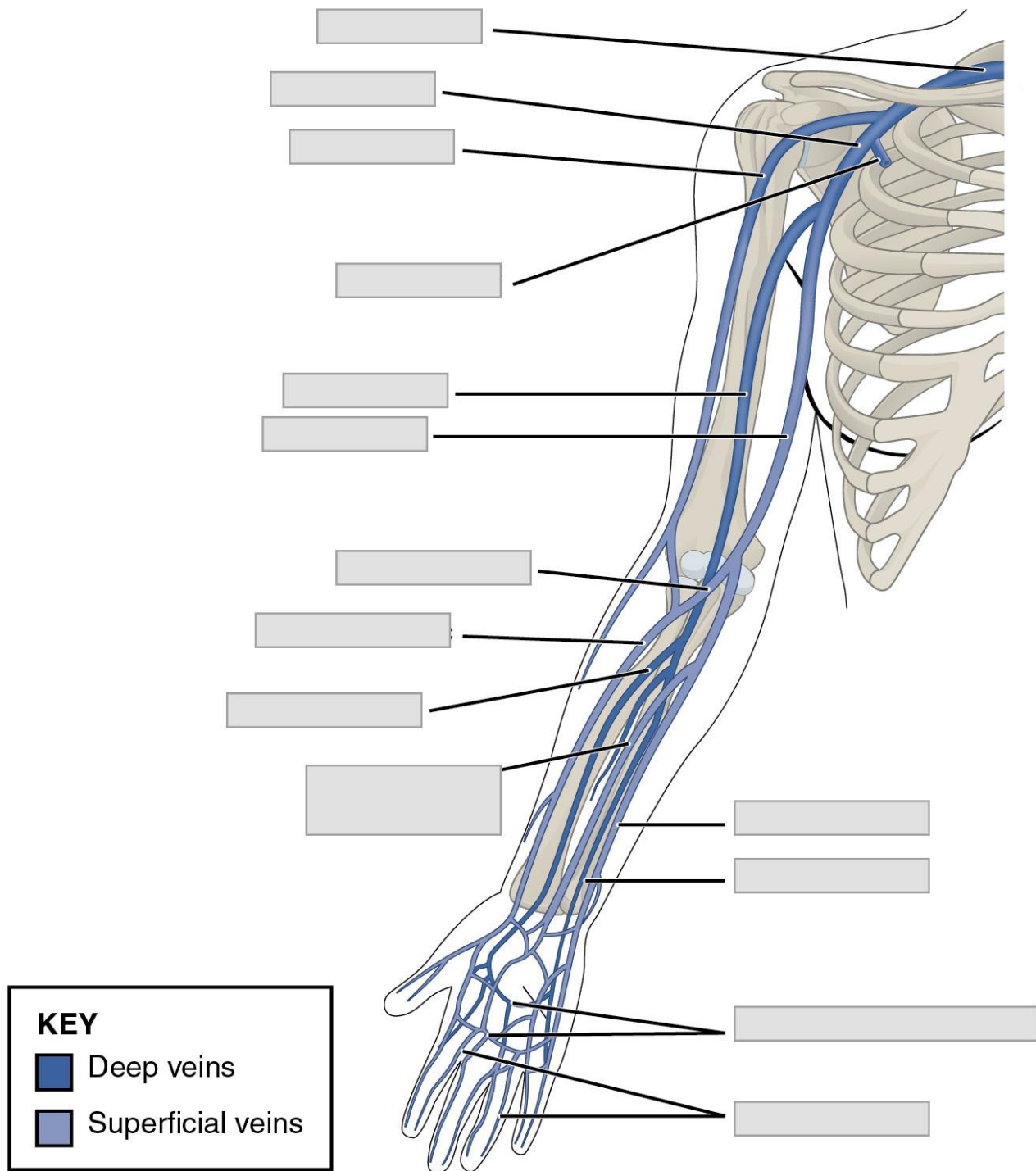


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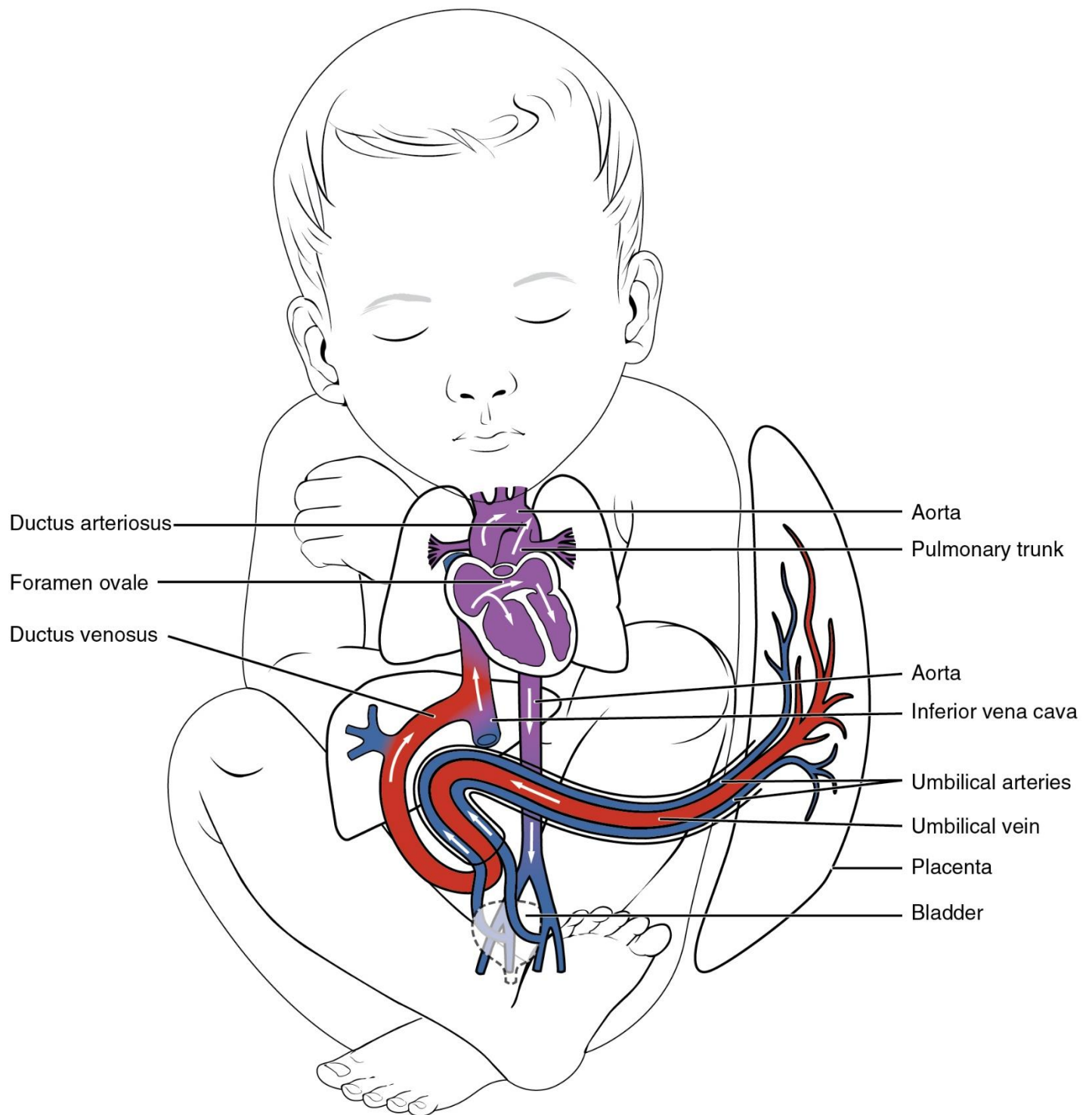




Activity 5.3.2 Draw and label your own superior venous vessel map in the space provided below. It is recommended that you only identify the vessels which have been indicated on your superior vessels list

Activity 5.3.3 Draw and label your own superior arterial AND venous vessel map in the space provided below. It is recommended that you only identify the vessels which have been indicated on your superior vessels list

## Activity 5.4 Fetal Vessel Shunts and Blood Flow Pathways



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

