Heart

The heart could be called the engine of life. This incredibly powerful organ works constantly, never pausing. Composed of a type of muscle found nowhere else in the body, the heart works to pump blood throughout the body, delivering oxygen-rich blood to organs and tissues and returning oxygen-poor blood to the lungs.

About the size of a fist, the heart lies in the thoracic cavity in the **mediastinum**, a space between the lungs and beneath the sternum. The heart tilts toward the left, so that two-thirds of it extends to the left of the body's midline. The broadest part of the heart, called the **base**, is at the upper right, while the pointed end, called the **apex**, is at the lower left.

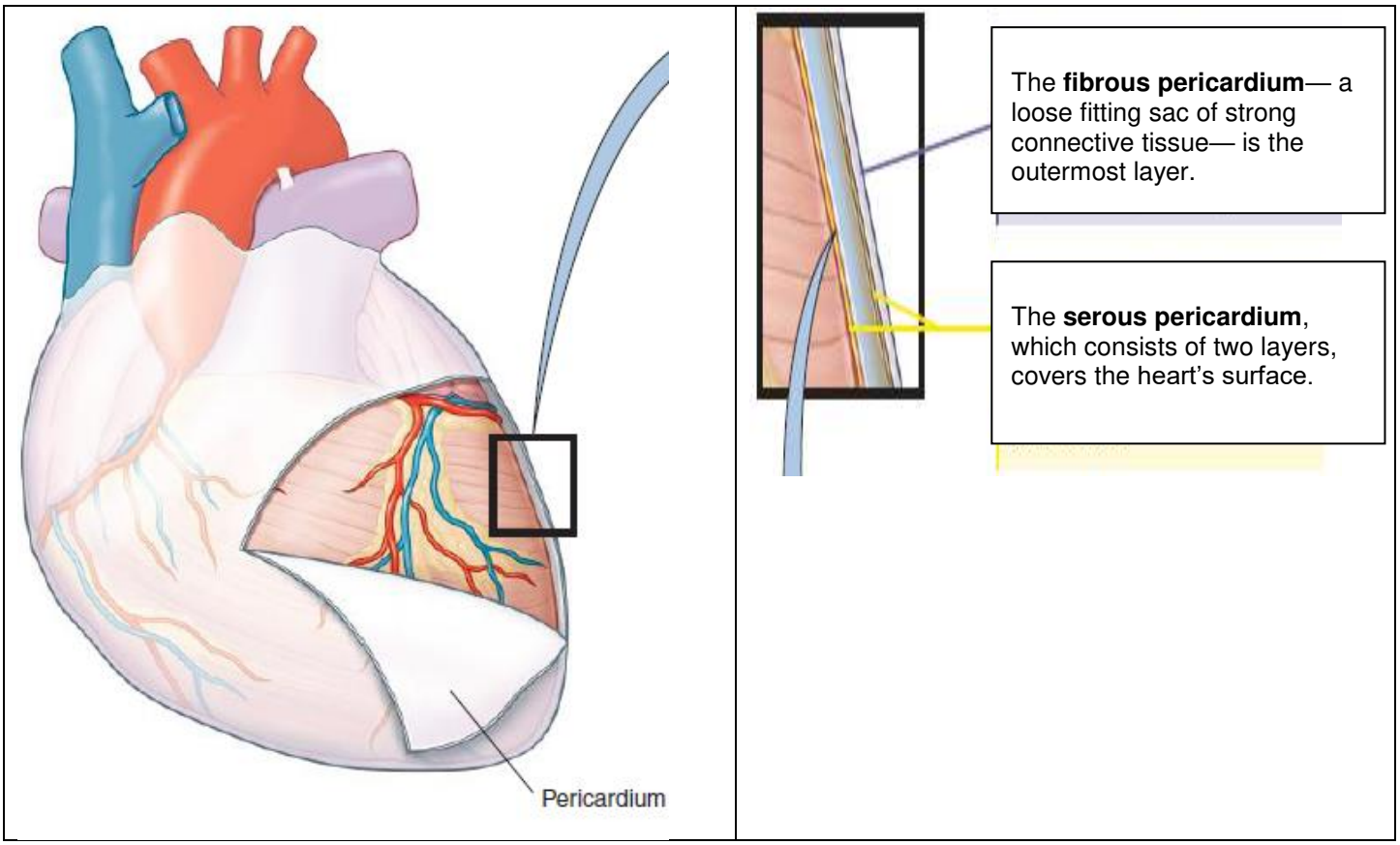
The study of the heart and the treatment of related disorders is called **cardiology**.

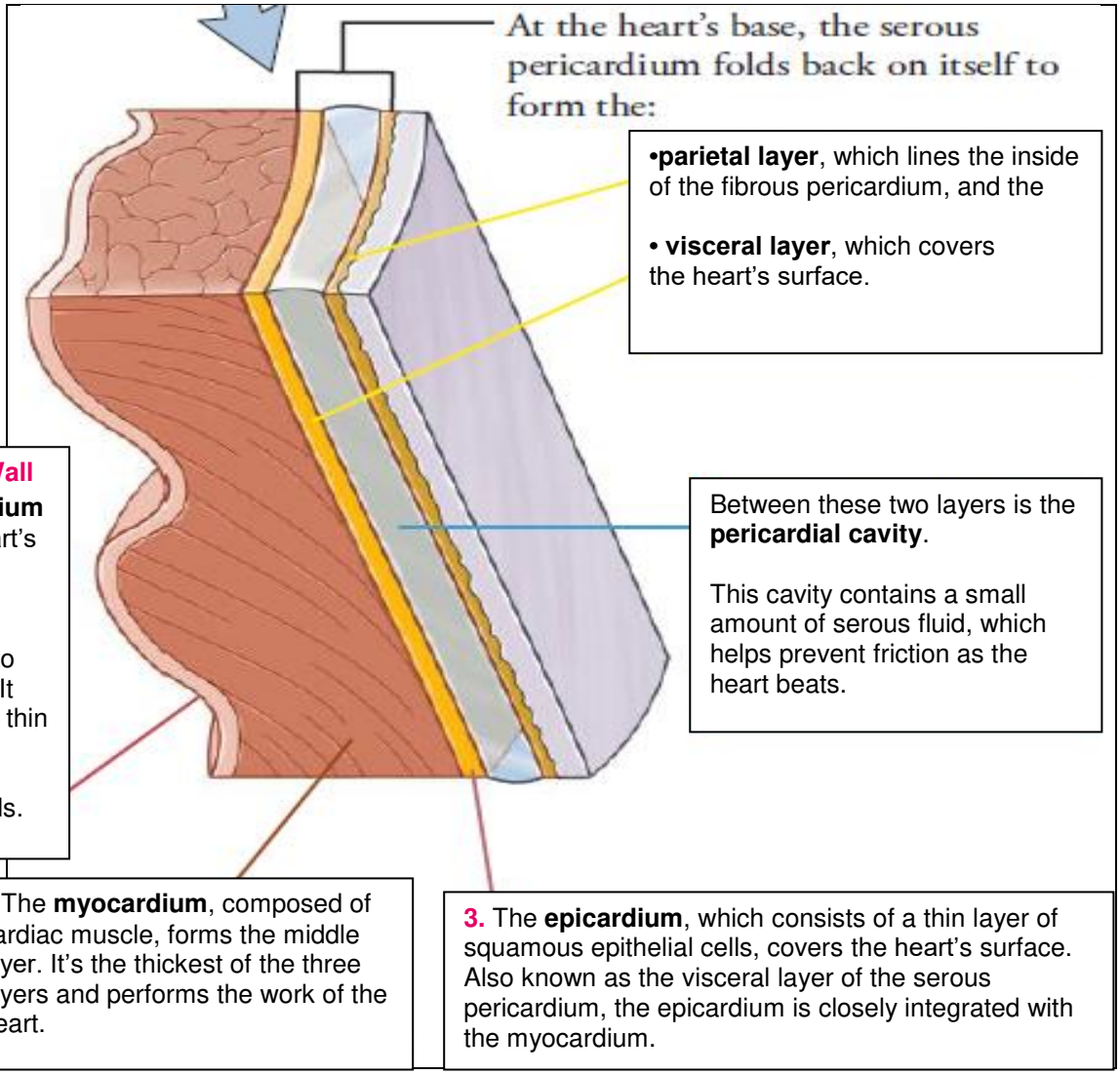
Structures of the Heart

Key structures of the heart include the pericardium, the heart wall, the chambers, and the valves.

The Pericardium

Surrounding the heart is a double-walled sac called the **pericardium**. Anchored by ligaments and tissue to surrounding structures, the pericardium has two layers: the fibrous pericardium and serous pericardium.





Note:

The endocardium is very smooth, an important characteristic that helps keep blood from clotting as it fills the heart's chambers.

The Heart Chambers and Great Vessels

The heart contains four hollow chambers. The two upper chambers are called **atria** (singular: **atrium**); the two lower chambers are called **ventricles**.

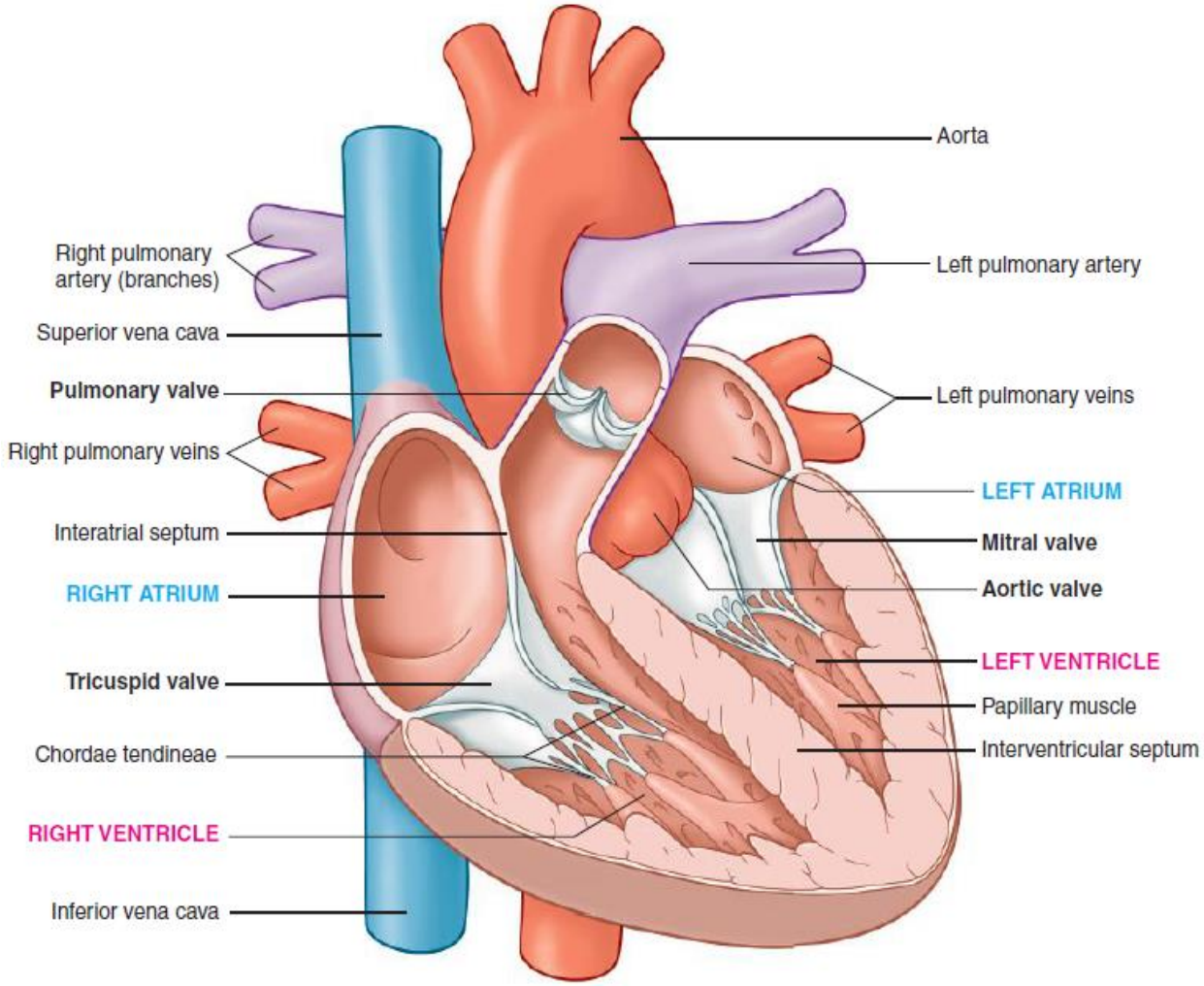
Attached to the heart are several large vessels that transport blood to and from the heart. Called **great vessels**, they include the superior and inferior vena, pulmonary artery (which branches into a right and left pulmonary artery), four pulmonary veins (two for each lung), and the aorta.

Atria

The atria serve primarily as reservoirs, receiving blood from the body or lungs. The right and left atria are separated by a common wall of myocardium called the **interatrial septum**. Because the atria move blood only a short distance— from the atria to the ventricles— they don't have to generate much force. Consequently, the walls of the atria are not very thick.

Ventricles

The ventricles serve as pumps, receiving blood from the atria and then pumping it either to the lungs (right ventricle) or the body (left ventricle). The right and left ventricles are separated by the **interventricular septum**. Because the ventricles pump rather than receive blood, they must generate more force than the atria. Therefore, the walls of the ventricles are thicker than those of the atria. Furthermore, because the left ventricle must generate enough force to push blood throughout the body, rather than just to the lungs, its walls are thicker than those of the right ventricle.



The Heart Valves

To ensure that blood moves in a forward direction through the heart, the heart contains four valves: one between each atrium and its ventricle and another at the exit of each ventricle. Each valve is formed by two or three flaps of tissue called **cusps** or **leaflets**.

The **atrioventricular (AV) valves** regulate flow between the atria and the ventricles.

- The right AV valve— also called the **tricuspid valve** (because it has three leaflets)— prevents backflow from the right ventricle to the right atrium.

● The left AV valve— also called the **bicuspid valve** (because it has two leaflets), or, more commonly, the **mitral valve**— prevents backflow from the left ventricle to the left atrium.

The **semilunar valves** regulate flow between the ventricles and the great arteries. There are two semilunar valves:

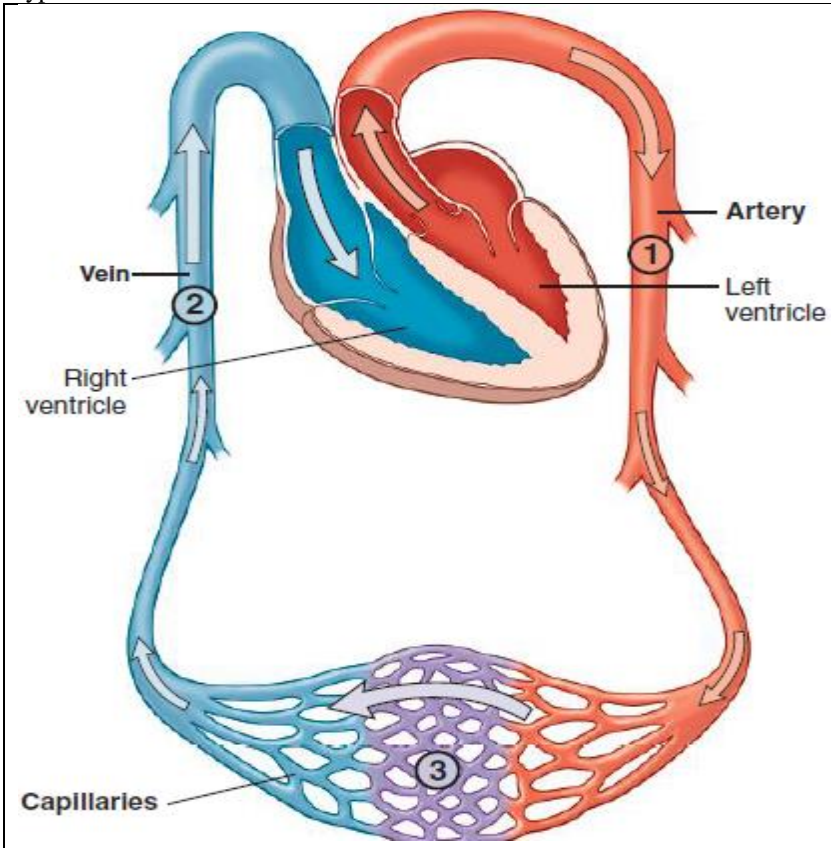
● The **pulmonary valve** prevents backflow from the pulmonary artery to the right ventricle.

● The **aortic valve** prevents backflow from the aorta to the left ventricle.

Valves open and close in response to pressure changes within the heart . For example, when a ventricle relaxes, the pressure within that ventricle drops. The AV valve leaflets hang limply, allowing blood to flow through the open valve into the ventricle. As the ventricle fills, pressure in the ventricle rises. After filling, the ventricle begins to contract and the pressure rises even more. This increased pressure pushes against the cusps of the AV valve, causing it to snap closed. When pressure in the ventricle exceeds the pressure "downstream," the semilunar valve pops open, allowing blood to flow out into the area of lower pressure.

Vascular System

When the body is at rest, only 4% of the blood is in the heart; the rest is in the blood vessels. Of that, about 13% is in circulation in the brain. The framework of this system consists of three types of blood vessels:



1.Arteries
carry blood *away* from the heart.

2.Veins
return blood to the heart.

3.Capillaries
connect the smallest arteries to the smallest veins.

Arteries

Arteries carry blood away from the heart. Every time the heart contracts, it forcefully ejects blood into the arteries. Therefore, arteries must be strong as well as resilient to withstand these high pressures. The arteries closest to the heart are the largest. As they travel farther away from the heart, the arteries branch and divide, becoming ever smaller. Finally, they become **arterioles,** which are the smallest arteries. Arteries can be divided into conducting arteries, distributing arteries, and arterioles.

Conducting Arteries

- The body's largest arteries, these arteries expand as blood surges into them and recoil when the ventricles relax.
- Because of the large number of elastic fibers embedded in the tunica media, they are also called **elastic arteries**.
- *Examples:* Aorta, common carotid artery, subclavian artery

Distributing Arteries

- These arteries carry blood farther away from the heart to specific organs and areas of the body.
- Also called **muscular arteries,** these arteries are smaller in diameter than elastic arteries.
- *Examples:* Brachial, femoral, and renal arteries

Arterioles

- These are the smallest arteries.
- They're also called **resistance vessels** because, through the contraction of smooth muscle in their walls, they can resist the flow of blood, thus helping regulate blood pressure as well as control how much blood enters an organ.
- They are too numerous to be named.
- Arterioles are connected to capillaries by short connecting vessels called **metarterioles**

Veins

Blood returns to the heart through veins. In contrast to arteries that branch and divide, forming progressively smaller vessels as they lead away from the heart—veins converge, forming progressively larger and fewer vessels as they lead back to the heart. Either way, the vessels closest to the heart are the largest. Veins are distinct from arteries in other ways:

- Because they aren't subjected to the same high pressures as arteries, the walls of veins are thinner.
- Veins have a great ability to stretch, which allows them to carry varying amounts of blood with almost no change in pressure. Because of this great capacity for storing blood, they're sometimes called **capacitance vessels.**
- Veins can constrict extensively. This helps the body maintain blood pressure when blood volume drops, such as from a hemorrhage.

Large Veins

- Formed as medium-sized veins converge, these veins have a thick tunica externa.

- *Examples:* Vena cavae, pulmonary veins, internal jugular veins

Medium-Sized Veins

- Formed by the convergence of venules on their route toward the heart, medium sized veins have thicker, more elastic walls.
- These veins contain one-way valves. Formed from the thin endothelium lining, valves keep blood moving toward the heart and prevent backflow. Veins in the legs, which must fight the forces of gravity as they transport blood to the heart, contain the most valves.
- *Examples:* Radial and ulnar veins of the forearm, saphenous veins in the legs

Venules

- These are the smallest veins and collect blood from capillaries.
- The endothelium consists of squamous epithelial cells and acts as a membrane; the tunica media is poorly developed, giving venules thinner walls.
- They are porous and can exchange fluid with surrounding tissues.

Capillaries

Capillaries are microscopic vessels that link arterioles to venules. More importantly, it's within capillaries that nutrients, wastes, and hormones are transferred between blood and tissues. These are the **exchange vessels** of the circulatory system. Properly functioning capillaries are as vital to survival as a properly beating heart. For this reason, no cell in the body is more than four or six cell-widths from a capillary.

Capillaries aren't evenly distributed, however. Tissues with high metabolic rates—such as the liver, kidneys, and myocardium—contain large numbers of capillaries. Fibrous connective tissues, such as tendons, have lower metabolic rates and contain fewer capillaries. Still other tissues—such as the epidermis, cartilage, and the lens and cornea of the eye—don't have any capillaries.

Sinusoid

Some organs—such as the liver, bone marrow, and spleen—contain a unique capillary called a **sinusoid**. These irregular, blood-filled spaces are more permeable, allowing for the passage of large substances such as proteins and blood cells. This is how blood cells formed in bone marrow as well as clotting factors and other proteins synthesized in the liver enter the bloodstream.

The **thoracic aorta** and its branches supply the chest wall and the organs within the thoracic cavity.

The **abdominal aorta** gives rise to the
1.**Celiac trunk**, which divides into the **gastric artery** (which supplies the stomach), the **splenic artery** (which supplies the spleen), and the **hepatic artery** (which supplies the liver):

2.Renal arteries, which supply the kidneys

3.Superior mesenteric artery, which supplies most of the small intestine and part of the large intestine

4.Inferior mesenteric artery, which supplies the other part of the large intestine

iliac arteries, which supply the pelvic organs, thigh, and lower extremities.
Major arteries branching off the iliac arteries include the:

1.Internal iliac artery

2.External iliac

3.Femoral artery

4.Popliteal artery

5.Anterior tibial artery

6.Posterior tibial artery

7.Dorsalis pedis artery

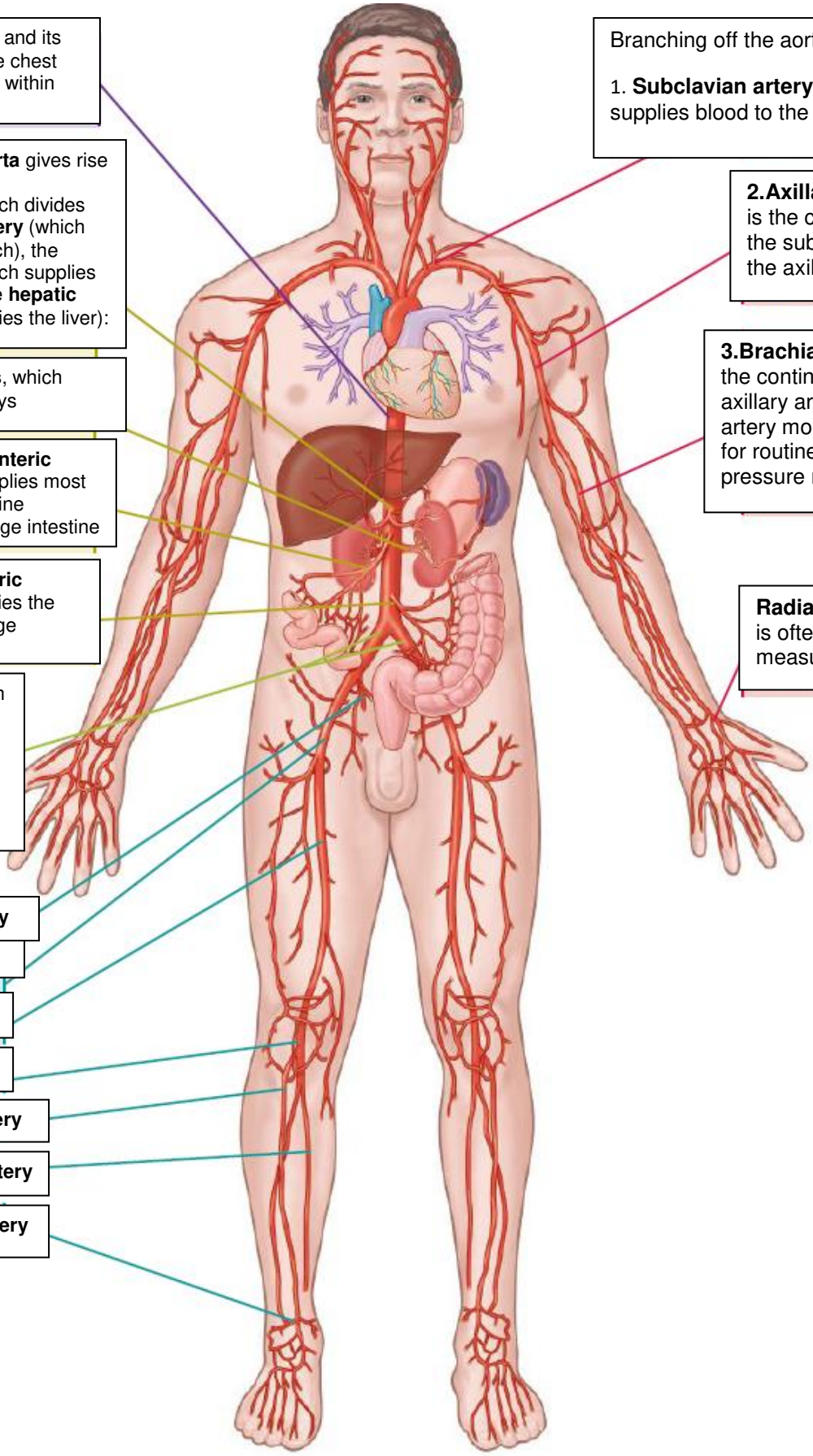
Branching off the aortic arch is the:

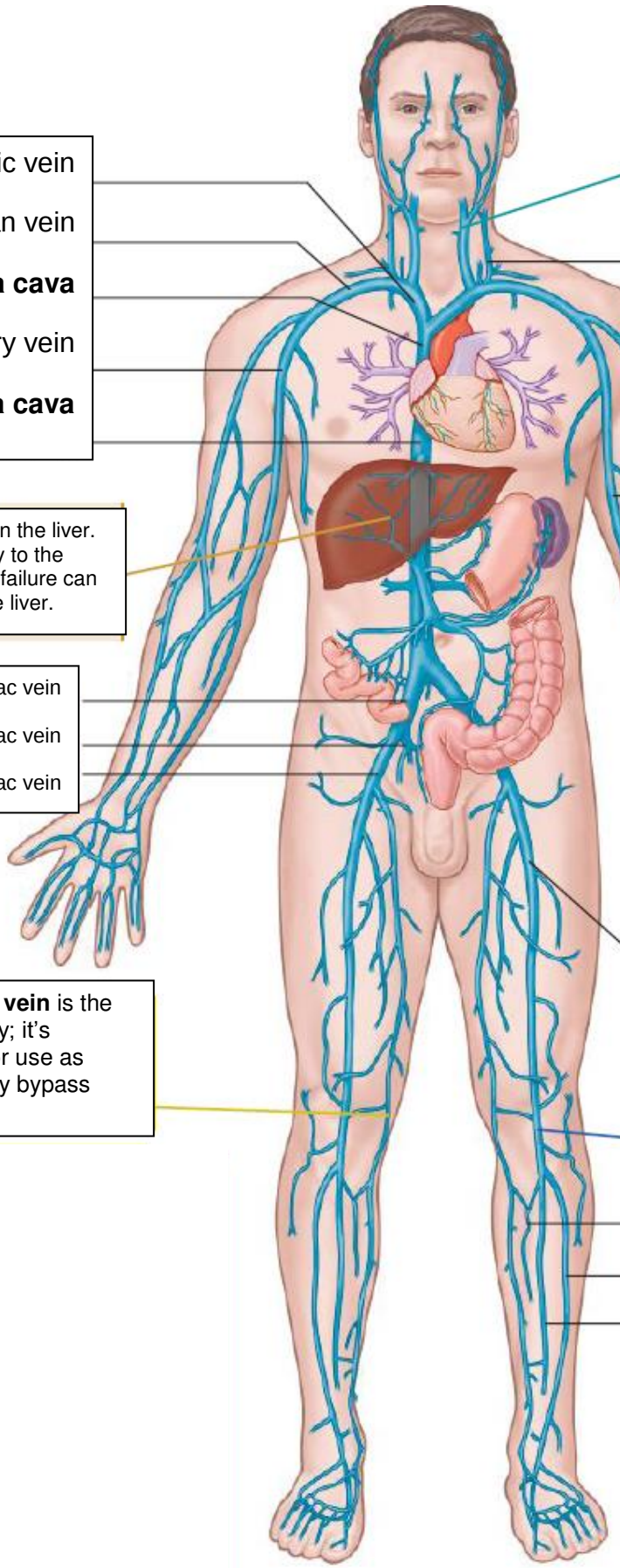
1. **Subclavian artery**, which supplies blood to the arm

2.Axillary artery, which is the continuation of the subclavian artery in the axillary region

3.Brachial artery, which is the continuation of the axillary artery and the artery most often used for routine blood pressure measurement

Radial artery, which is often palpated to measure a pulse





Brachiocephalic vein

Subclavian vein

Superior vena cava

Axillary vein

Inferior vena cava

The **internal jugular vein** drains most of the blood from the brain. In right-sided heart failure, blood backs up from the heart and causes jugular vein distension.

External jugular ve

The **cephalic vein**, at its distal end, is a frequent site for the administration of intravenous fluids.

Basilic vein

The **hepatic veins** drain the liver. Because of its proximity to the heart, right-sided heart failure can cause congestion in the liver.

The **median cubital** vein is the most common site for drawing blood.

Common iliac vein

Internal iliac vein

External iliac vein

Radial vein

Femoral vein

The **great saphenous vein** is the longest vein in the body; it's frequently harvested for use as grafts in coronary artery bypass surgery.

The **popliteal vein** runs behind the knee.

Fibular (peroneal) vein

Anterior tibial vein

Posterior tibial vein