MODULE 2: CARDIOVASCULAR SYSTEM ANTOMY

An Introduction to the Anatomy of the Heart and Blood vessels

The cardiovascular system includes a pump (the heart) and the vessels that carry blood from the heart to body tissues (arteries) and from the body tissues back to the heart (veins). The table below includes a list of terms that you will be expected to identify on pictures, models and images. There will likely be images on the exam that you have not seen or studied before, so it is important for you to learn anatomical structures by their characteristics and avoid just memorizing the pictures you have available.

List of Terms

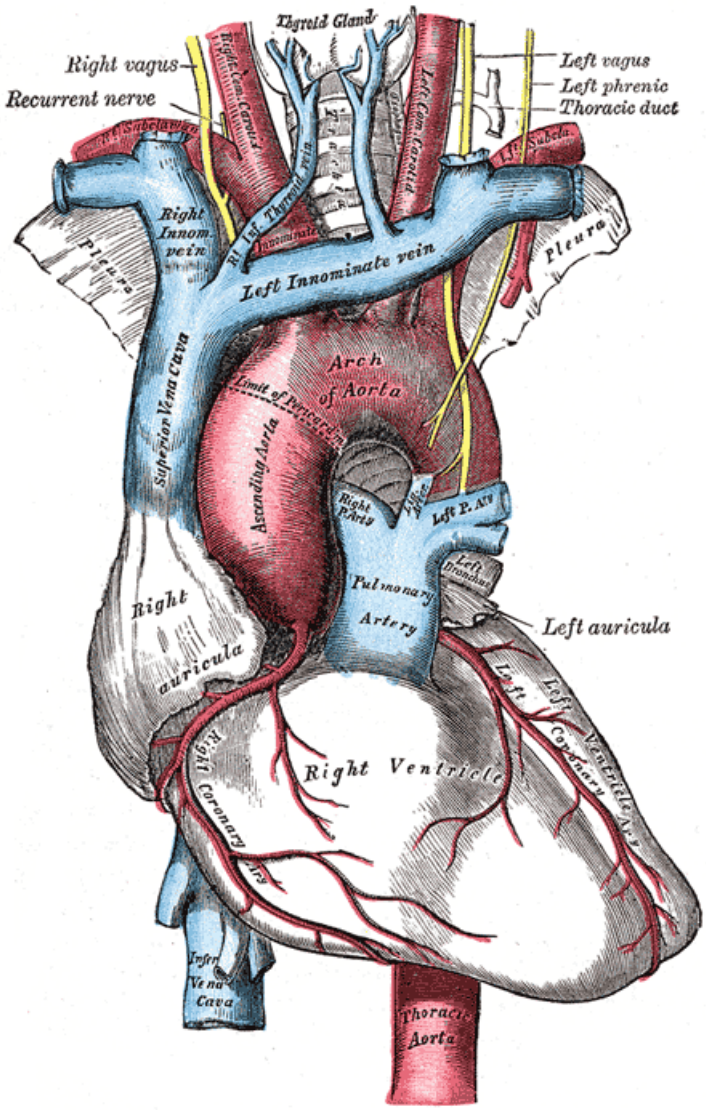
Spend as much time as you need reviewing cardiovascular anatomy. Practice identifying all of the structures listed in the tables below. Use your online resources, open lab, and any other tool that you have to become confident in your identification skills. Even though the practice exam will be multiple choice, the real lab exams will ask you to identify and then write in (Fill in the Blank) the correct term for your identification. The tables below include a comprehensive list of all the terms from this section that we would consider asking about on an exam.

LIST OF TERMS FOR THE ANATOMY OF THE HEART	
Layers of the Heart Wall • **Epicardium** • **Myocardium** • **Endocardium**	The walls of the heart are composed of three layers of tissue. The **Epicardium** is a thin simple squamous epithelium. It is the same thing as the visceral pericardium. We call it Epicardium when we are referring to it in language about the heart. We call it the visceral pericardium when we are referring to it in reference to the deepest layer of the pericardium. The **Myocardium** is the layer of cardiac muscle cells. The **Endocardium** is another layer of simple squamous epithelium. It is continuous with the inner layer of all the blood vessels of the heart. Though not shown in the online atlas, endocardium also covers the valves of the heart.

Anatomical Landmarks of the Heart • **Apex** • **Base** • **Anterior Surface** • **Posterior Surface**	The **Apex** of the heart is the most inferior point of the heart. The heart is wider on top and narrower at the inferior tip, so it is like an upside down triangle. The **Base** of the heart is the opposite end of the apex. The base of the heart is formed largely by the left atrium with a smaller contribution of the right atrium. The **Anterior and Posterior Surfaces** of the heart are self-explanatory. It will be important that you can recognize these surfaces from any view of the heart and on a heart that is not shown in the body cavity.
Chambers of the Heart • **Right Atrium** ➢ **Right Auricle** • **Left Atrium** ➢ **Left Auricle** • **Right Ventricle** • **Left Ventricle** • **Interatrial Septum** • **Interventricular Septum**	The **Right and Left Atria** are two of the four blood collecting chambers of the heart. The atria sit on the superior end of the heart. The right atrium receives blood from the superior and inferior vena cavae. The blood entering the right atrium is venous blood and is low in oxygen. The left atrium receives blood coming from the lungs and is high in oxygen. The **Auricles** are part of the atria. It is not uncommon for the terms atrium and auricle to be used interchangeably, but technically speaking the auricle is a small muscular pouch at the upper and front parts of the two atria. The **Right Ventricle** is the lower right hand chamber of the heart. It sits just below the right atrium. The right ventricle contracts and moves blood into the pulmonary trunk and arteries which travel to the lungs. The **Left Ventricle** is the lower left chamber of the heart. The left ventricle contracts and moves blood into the aorta which carries blood forward to feed arteries of the body. The **Interatrial Septum** is a wall of connective tissue that seperates the right and left atria.Similarly, the **Interventricular Septum** is a wall of muscular and connective tissue that seperates the right and left ventricle.

Blood Vessels of the Heart

- **Aorta**
  - **Ascending Aorta**
  - **Aortic Arch**
  - **Descending (Thoracic) Aorta**
- **Brachiocephalic (Innominate) Artery**
- **Left Common Carotid Artery**
- **Left Subclavian Artery**
- **Superior Vena Cava**
- **Inferior Vena Cava**
- **Pulmonary Trunk (Artery)**
- **Right Pulmonary Artery**
- **Left Pulmonary Artery**
- **Right Pulmonary Vein**
- **Left Pulmonary Vein**



The **Aorta** is the largest artery in the human body. It originates from the left ventricle. It resembles a cane as it curves superiorly and then descends in a long straight path through the thorax just anterior to the thoracic vertebrae. Rising from the arch are three large arteries. From right to left they are named **Brachiocephalic**, **Left Common Carotid** and **Left Subclavian**. Notice that the brachocephalic is just a short connector that quickly gives rise to a **Right Common Carotid** and a **Right Subclavian**. In some mammals, there is no brachiocephalic connector. Instead, the right common carotid and right subclavian descend all the way down and join the aorta. So, in these mammals there would be four main arteries on the aortic arch instead of three. The **Inferior and Superior Vena Cava** join the right atrium and carry blood from the veins of the body. The **Pulmonary Trunk** is also referred to as a **Pulmonary Artery**. Arteries always take blood away from the heart and veins always bring blood to the heart. So, even though pictures often depict the pulmonary artery as blue (low in oxygen), it is still an artery because it is taking blood away from the heart and to the lungs. The **Right and Left Pulmonary Arteries** are just continuations of the main pulmonary trunk or artery. The **Right and Left Pulmonary Veins** cannot be seen in the picture here to the left. But, since they are called veins we know that they are bringing blood to the heart. Also, because of the name pulmonary we know they are coming from the lungs, so we would expect their color to be red. You can see examples of pulmonary veins on the online atlas.

Coronary Arteries

- **Left Coronary Artery**
  - **Anterior Descending (Interventricular) Artery**
  - **Circumflex Artery**
  - **Left Marginal Artery**
- **Right Coronary Artery**
  - **Right Marginal Artery**
  - **Posterior Descending (Interventricular) Artery**

The Blood Vessels of the heart previously discussed in the last section carried blood away from the heart and to the body. The **Coronary Arteries** carry blood to the heart pump itself. The heart, like any other tissue or organ in the body, needs oxygen and nutrients to survive. The **Right and Left Coronary Arteries** branch off of the aorta just as it arises from the left ventricle. The oxygenated blood leaving the left ventricle enters the coronary arteries and gets carried to the epicardial and myocardial layers of the heart. As the coronary arteries travel, they take on different names as they branch and pass specific landmarks on the heart. The right coronary artery becomes the **Right Marginal Artery** as it descends down the right margin of the right ventricle. A branch of the right coronary artery can also wrap around the superior end of the right ventricle and descend the heart between the posterior ventricles. This artery is called the **Posterior Descending Artery**. It is also often called the **Posterior Interventricular Artery**. The posterior interventricular artery arises from the right coronary artery 70% of the time. This means that there are some individuals who have this artery arise from the left coronary (cirumflex) branch and some individuals who have this artery arise from both. This is why the model we use in lab shows two arteries making up the posterior interventricular artery. The left coronary artery gives rise to the **Anterior Descending Artery**. It is also frequently referred to as the **Left Anterior Interventricular Artery**. Unlike the posterior version of this artery, the anterior interventricular artery always arises from the left coronary. The left coronary artery also branches to become the **Left Marginal Artery** which descends down the left margin of the left ventricle. Finally, the **Circumflex Artery** branches off of the left coronary and wraps around the left ventricle where it may or may not contribute to the posterior interventricular artery.

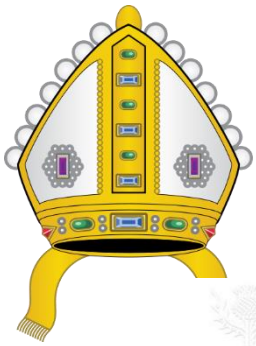
Cardiac Veins

- **Anterior Interventricular Vein**
- **Posterior Intervenricular Vein**
- **Coronary Sinus**

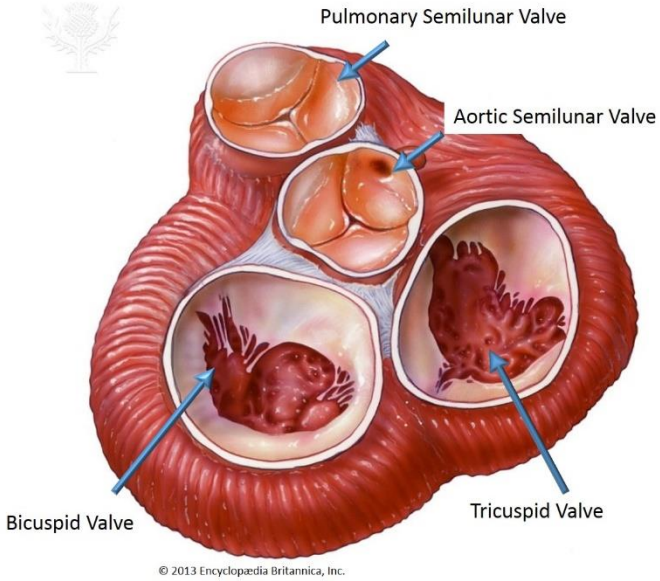
The cardiac veins have more variability in humans that the arteries. There may be more than one vein contributing to the interventricular drainage. Generally, though there is a dominant vessel that we can correctly refer to at the Anterior Interventricular Vein and Posterior Interventricular Vein. All the veins of the heart ultimately culminate on the posterior surface of the heart over the superior right ventricle and inferior to the right atrium. The vein at this point is quite large and it opens up into the right atrium. So, all the venus blood of the heart returns to the right atrium in a deoxygenated form to be recycled to the lungs.

Valves

- **Tricuspid (Right Atrioventricular) Valve**
- **Bicuspid (Left Atrioventricular) Valve**
- **Chordae Tendineae**
- **Papillary Muscles**
- **Aortic Semilunar Valve**
- **Pulmonary Semilunar Valve**



Mitre



The valve that acts as a gate between the right atrium and the right ventricle is a called the **Right Atrioventricular Valve**. It is also very common to just refer to it as the **Tricuspid Valve**. The term "tricuspid" refers to the fact that this valve has three leaflets and three papillary muscles holding three sets of chordae tendineae. **Papillary Muscles** are small muscular structures located inferior to the atrioventricular valves. Arising from papillary muscles are chordae tendineae. **Chordae Tendineae** are "string" like tissues that connect papillary muscles to the leaflets of the valves. The purpose of the papillary muscle and chordae tendineae is to put tension on the atrioventricular valve leaflets so that they don't push back into the atria when the ventricle contracts. The **Left Atrioventricular Valve** operates the same way as the right, but it only has two leaflets instead of three. Therefore, it is very commonly called the **Bicuspid Valve.** Another name that shows up in the literature for the Bicuspid valve is the "Mitral" valve. Mitral is a term that references a Mitre, which is a type of head gear worn by authorities in the Catholic Church. The Mitre resembles a bicuspid valve in its appearance (See image to left). The **Aortic and Pulmonary Semilunar Valves** are found between the ventricles and the large vessels that exit the ventricle. The term semilunar refers to the shape of the leaflets. There are three leaflets and they are kind of triangular in shape, which must have reminded some ancient anatomist of a half moon, thus the term "semilunar".

Trabeculae Carneae

The term "**Trabeculae Carneae**" means "meaty ridges". Indeed the inside of the heart chambers (especially the ventricles) has many rounded or irregular muscular columns.

Embryonic Remnants

- **Ligamentum Arteriosum**
- **Fossa Ovalis**

There are a couple of structures that we want you to learn in the heart that come from the fetal heart but do not function in the child or adult heart. At least they shouldn't function after birth, and if they do it leads to heart problems. The first is the **Ligamentum Arteriosum**. This is called the Ductus Arteriosum in the fetus. It is a shunt that allows blood to move from the pulmonary trunk to the aorta. Since the lungs are not functioning in the fetus, there is no need to send blood to the lungs for oxygen. Rather, oxygenated blood from the placenta gets shunted to the left side of the heart for quick passage to the body tissues. The **Fossa Ovalis** is called the Foramen Ovalis in the fetus. This is an opening between the right and left atria. This is another structure that allows blood to shunt to the left side of the heart and bypass the lungs. After we are born these shunts close off, but the remnants can still be seen.

Conducting System of the Heart

- **Sinoatrial (SA) Node**
- **Atrioventricular (AV) Node**
- **Atrioventricular Bundle (Bundle of His)**
- **Bundle Branches**
- **Conduction Myofibers (Purkinje Fibers)**

The **Conducting System of the Heart** allows an electrical impulse to be generated in the superior pole of the heart and then travel to through the heart in a way that allows heart muscle to contract in a pumping coordinated fashion. The electrical signal starts in the **SA Node** which is a group of cells located in the superior – posterior right atrium. The signal travels through the atrial myocardium and converges on the **AV Node** which is an area of tissue located in the posterior – inferior region of the interatrial septum. The AV Node depolarizes relatively slow and so a pause occurs as the electrical signal passes through the AV Node. When the electrical signal does pass through the AV node tissue, the group of cells located in the depolarizes. The bundle of his is a collection of heart muscle cells that are specialized for conduction of electrical signals. The electrical signal moves through the bundle of his and then branch into the right and left **Bundle Branches**. The bundle branches carry the signal to the apex of the heart and then branch back superiorly deep (through the myocardium) via **Purkinje Fibers**. Purkinje Fibers conduct electrical signals faster than any other conducting cells of the heart.

LIST OF TERMS FOR THE ANATOMY OF CIRCULATORY SYSTEM

Arteries

- **Aorta**
  - **Ascending Aorta**
  - **Aortic Arch**
  - **Descending Aorta**
- **Arteries of the Arms and Neck**
  - **Brachiocephalic Artery**
  - **Common Carotid Arteries**
  - **Subclavian Arteries**
  - **External Carotid Arteries**
  - **Internal Carotid Arteries**
  - **Vertebral Arteries**
  - **Right Axillary Artery**
  - **Right Brachial Artery**
  - **Right Radial Artery**
  - **Right Ulnar Artery**
- **Arteries of the Abdomen**
  - **Thoracic Aorta**
  - **Abdominal Aorta**
  - **Celiac Trunk**
  - **Gastric Artery**
  - **Splenic Artery**
  - **Hepatic Artery**
  - **Superior Mesenteric Artery**
  - **Renal Artery**
  - **Gonadal Artery**
  - **Inferior Mesenteric Artery**
  - **Common Iliac Artery**
  - **External Iliac Artery**
  - **Internal Iliac Artery**
- **Arteries of the Leg**
  - **Right Femoral Artery**
  - **Right Deep Femoral Artery**
  - **Right Popliteal Artery**
  - **Right Anterior Tibial Artery**
  - **Right Posterior Tibial Artery**

There are a lot of blood vessels in our body. Our attempt here is to introduce some of the major ones. Later when you take more advanced anatomy classes, you may learn many more vessels, but they will generally be branches or derivatives of the ones you learn here.

One way we recommend learning blood vessels is to visualize them as a circulatory "Tree". Students who practice sketching this tree out by memory usually do quite a bit better on the exams.

To help you visualize this "Tree" we have included some examples and an interactive tutorial in the online atlas. Locate this helpful material in the "Practice" section at the bottom.

When learning and naming blood vessels, be sure to identify right and left. Blood vessels in the extremities are only shown for the right in the online atlas, but everything would be mirrored on the left.

Veins

- **Veins of the Chest, Neck and Arms**
  - **Right Atrium**
  - **Superior Vena Cava**
  - **Brachiocephalic Veins**
  - **External Jugular Veins**
  - **Internal Jugular Veins**
  - **Subclavian Veins**
  - **Right Axillary Vein**
  - **Right Basilic Vein**
  - **Right Brachial Vein**
  - **Right Cephalic Vein**
  - **Right Median Cubital Vein**
  - **Right Ulnar Vein**
  - **Right Radial Vein**
- **Veins of the Abdomen**
  - **Inferior Vena Cava**
  - **Hepatic Veins**
  - **Hepatic Portal Vein**
  - **Splenic Vein**
  - **Superior Mesenteric Vein**
  - **Inferior Mesenteric Vein**
  - **Renal Veins**
  - **Gonadal Veins**
  - **Common Iliac Veins**
  - **External Iliac Veins**
  - **Internal Iliac Veins**
- **Veins of the Legs**
  - **Right Femoral Vein**
  - **Right Deep Femoral Vein**
  - **Right Great Saphenous Vein**
  - **Right Popliteal Vein**