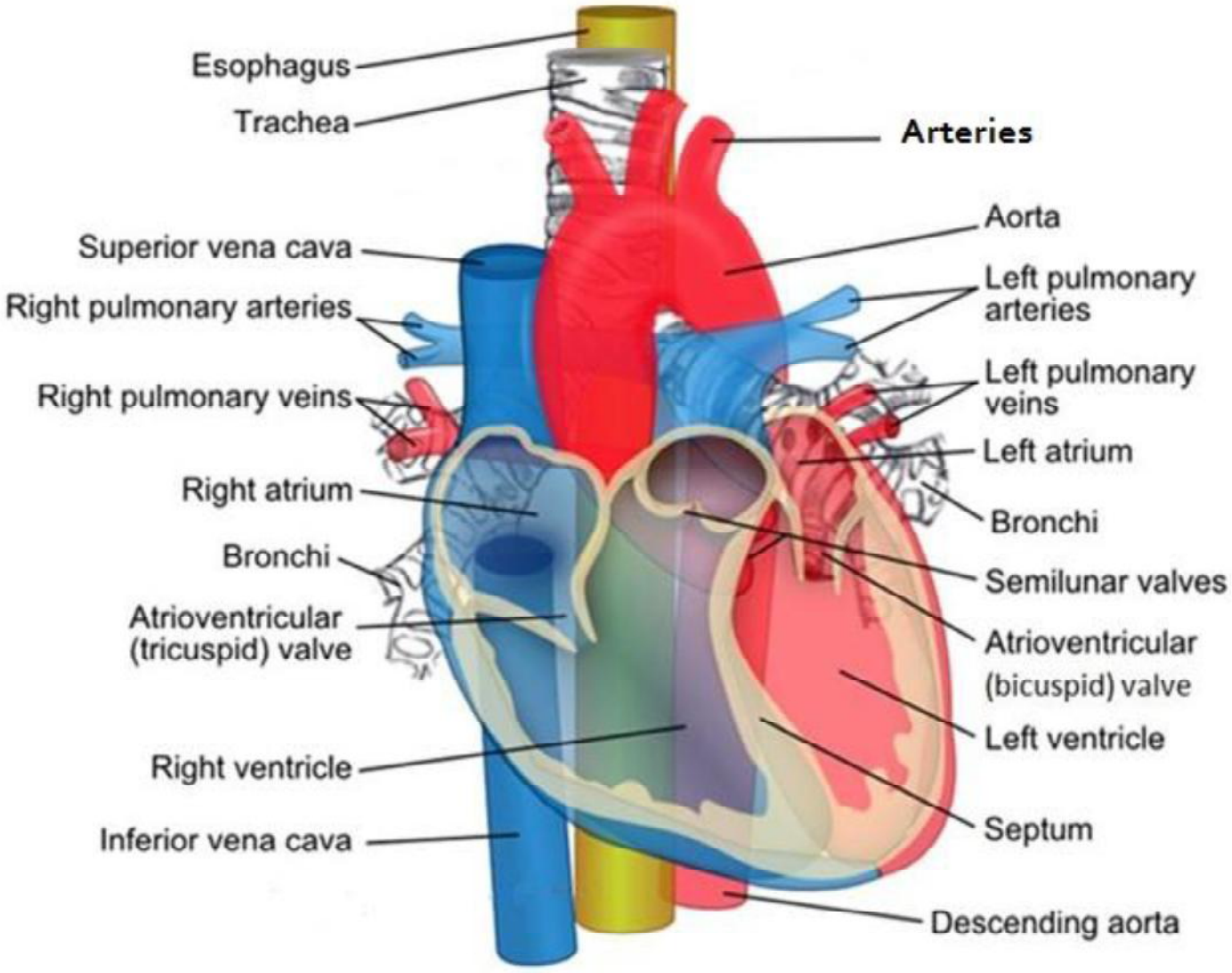
Chapter 17

Cardiovascular System – Part I

In the next two chapters we will be dealing with the main transport system of the blood within our body:

The Cardiovascular System

The **heart** is, by far, the main character in this week's reading as it provides the driving force for the circulation of blood. Although the size of this organ varies with its owner, it is approximately the size of one's fist and is located within the protective ribcage of our chest.



The heart is divided into four separate chambers. The two upper chambers are known as **atria** and the two lower chambers are called **ventricles**.

Atria

The left atrium and right atrium are the upper chambers of the heart where blood is delivered into the heart through large blood vessels called **veins**.

Ventricles

The left and right ventricles are responsible for pumping blood out of the heart with the assistance of another type of blood vessel called **arteries**. These two chambers force blood to different areas of the body. Of the two ventricles, the left chamber is reinforced with thicker walls which make it larger in size than its partner. This extra girth is vital for the left ventricle as it has the added challenge of forcing blood throughout the entire body, unlike the right ventricle which only pumps blood towards the lungs.

Let's take a look at how blood is directed through the chambers of the heart.

When it is functioning correctly, blood flows in one direction through the four chambers of the heart and the body as well. Any backflow of blood is prevented by the presence of two different structures:

Atrioventricular valves and the Semilunar valves

In plumbing terms, **valves** are devices which control the passage of fluid through a pipe or a tube. Typically, a valve will allow fluids to travel in one direction; and, when backflow happens, the force of the fluid moving in the opposite direction pushes against the valve itself which closes the pathway. This is how the valves of the heart work as well. The valves we will be exploring are located between the four chambers of the heart and on the areas where blood is pumped out of the heart from the ventricles.

The **atrioventricular valves (AV)** are located between the right atrium and right ventricle (**tricuspid valve**) and left atrium and left ventricle (**bicuspid valve**).

The **semilunar valves (SV)** close after blood has exited the right ventricle (**pulmonary semilunar valve**) and left ventricle (**aortic semilunar valve**).

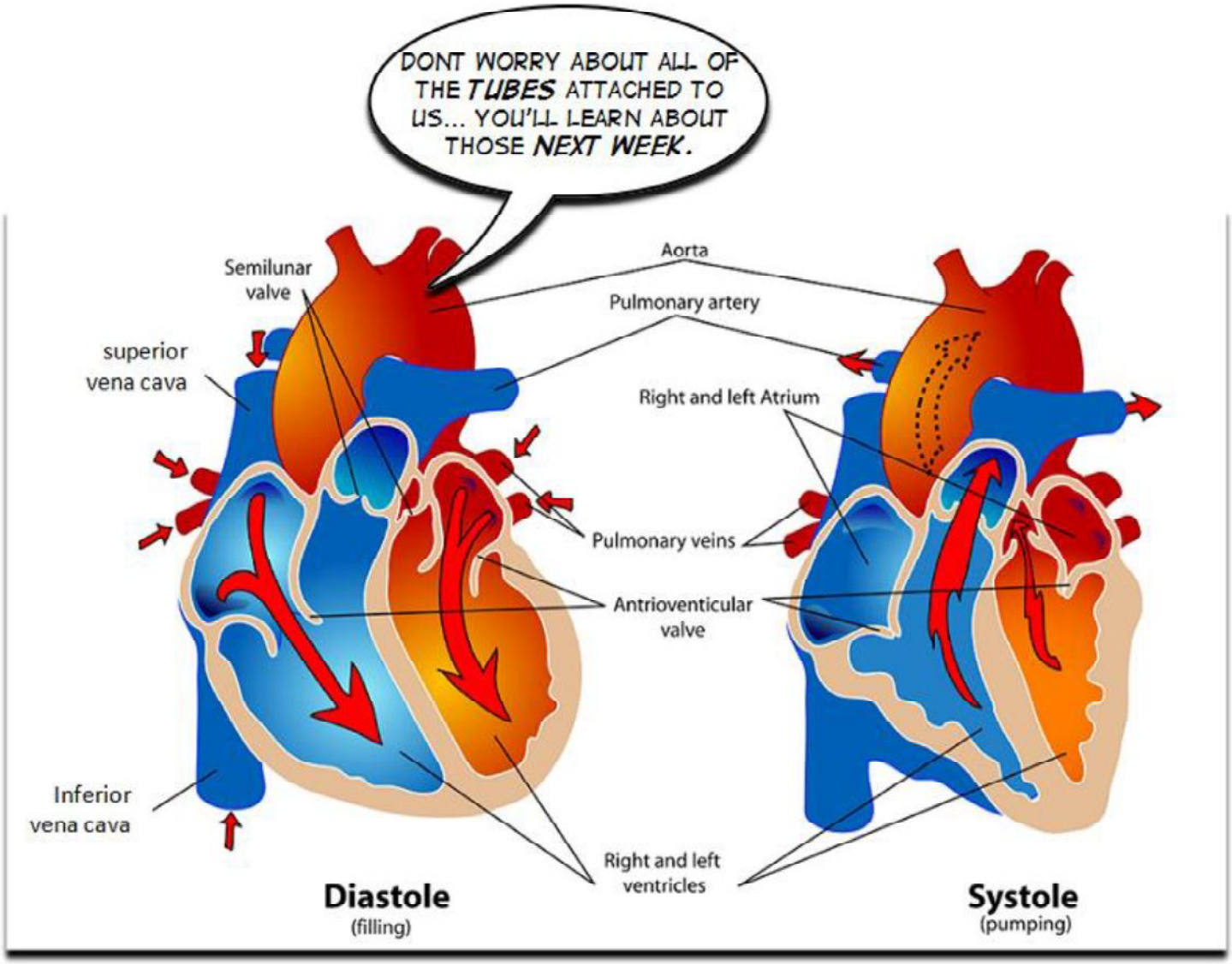
A very important "dance" occurs between these two different types of valves:

When the ventricles are relaxed and not pumping blood away from the heart, the atrioventricular valves are open and the semilunar valves are closed. To put it simply, a door opens and forces blood into the ventricles without any possibility of escape throughout the body as the exit door is closed.

When the ventricles contract and begin forcing blood throughout the body, the atrioventricular valves close and the semilunar valves open. In this sequence, the door which allowed blood to rush into the ventricles is closed as its exit doors are opened. Once the semilunar valves open, blood is forced out of the heart through the arteries.

You can hear these valves opening and closing all day long!

The opening and closing of your heart valves make a characteristic "lub-dub" sound. The first sound, the "lub" is the sound of your atrioventricular valves closing. This marks the beginning of **systole**, or the phase of the cardiac cycle where blood is forced out of the heart and into the arteries. The second "dub" sound is caused by the closing of the semilunar valves and begins a period of **diastole**. This period of time within the cardiac cycle is when the heart refills with blood after systole.



Back in Chapter 6, you briefly looked at the structure and function of cardiac muscle and how it is different from skeletal and smooth muscle tissues. You also learned that cardiac tissue can only be found within the structure of the heart. Its cells are striated in appearance due to the presence of sarcomeres and, unlike the long cylindrical skeletal muscle cells, cardiac muscle is branched much like that of a tree. Most importantly, these cells do not require a connection with the nervous system to create a nerve impulse. Cardiac muscle involuntarily contracts due to its ability to be self-stimulated through the presence of **pacemaker cells** within the heart tissue.

The pacemaker cells are located within the right atrium and generate a rhythmical flow of nerve impulses throughout all of the cardiac muscle tissue.

Although these nerve impulses resemble those found within skeletal and smooth muscle tissue, the contraction of cardiac muscle lasts nearly 10 times longer. The periodic resting periods between each "beat" of the heart allow these tissues to relax and they rarely become exhausted.

Your doctor can monitor the nerve impulses of your heart through specialized equipment as well.

An **electrocardiogram** is a device used by medical professionals to detect the electrical impulses generated by your cardiac muscle. This device is sensitive enough to detect any abnormal electrical impulse that may be generated by the contraction of your heart. These irregular patterns in nerve impulses are known as **arrhythmias** and can be potentially dangerous.

The following list will give you an overview of the pathway of the blood we have explored so far:

1. Right atrium
2. Tricuspid valve
3. Right ventricle
4. Pulmonary semilunar valve
5. *(Blood travels to the lungs)*
6. Left atrium
7. Bicuspid valve
8. Left ventricle
9. Aortic semilunar valve
10. *(Blood travels to the tissues/organs in the body)*
11. Right atrium (…and the process begins again!)

We'll fill in the gaps for #5 and #10 in the next chapter. For now, let's look at a few amazing facts about the heart...

If I asked you to place your hand over your heart, you would likely put your hand on the left side of your chest, correct? This is not entirely true as your heart is actually located in the center of the chest.

Within the course of one day, your heart beats about 100,000 times. This adds up to roughly 2.5 billion times in an average lifetime.

Approximately 2,000 gallons (7,571 liters) of blood is forced through your body daily.

Your body contains approximately 5.6 liters (6 quarts) of blood. This volume of blood circulates through the body every 20-60 seconds.

The heart pumps around 55,000,000 gallons (~207,000,000 liters) in an average lifetime. This would fill approximately 900,000 average-sized bathtubs.

In the next chapter, you will be exploring the pathway of the blood throughout the entire body. Stay tuned!

Match the following vocabulary terms with their correct definition:

aortic semilunar valve
arrhythmias
arteries
atria
atrioventricular valves
diastole
electrocardiogram
heart
pacemaker cells
pulmonary semilunar valve
semilunar valves
systole
tricuspid valve
valves
veins
ventricles

1)	_____	a device used to detect the electrical impulses generated by cardiac muscle
2)	_____	atrioventricular valve located between the right atrium and right ventricle
3)	_____	device which control the passage of fluid in one direction
4)	_____	irregular patterns in nerve impulses caused by pacemaker cells
5)	_____	large blood vessels responsible for carrying blood away from the heart and towards the various tissues of the body
6)	_____	large blood vessels which deliver blood into the left atrium and right atrium of the heart
7)	_____	located within the right atrium; generate a rhythmical flow of nerve impulses throughout all of the cardiac muscle tissue causing muscular contraction
8)	_____	main organ of the cardiovascular system; responsible

		for pumping all bodily fluids throughout each system
9)	_____	one of two valves which close after blood has exited the right ventricle (pulmonary semilunar valve) and left ventricle (aortic semilunar valve)
10)	_____	semilunar valve which closes after blood has exited the left ventricle
11)	_____	semilunar valve which closes after blood has exited the right ventricle
12)	_____	two lower chambers within the heart
13)	_____	two upper chambers within the heart
14)	_____	two valves located between the right atrium and right ventricle (tricuspid valve) and left atrium and left ventricle (bicuspid valve)
15)	_____	phase of the cardiac cycle where the heart refills with blood after systole
16)	_____	phase of the cardiac cycle where blood is forced out of the heart and into the arteries

Choose the correct answer from the following questions:

1) The right atrioventricular valve is known as the:

A) pulmonary semilunar valve
B) aortic semilunar valve
C) tricuspid valve
D) bicuspid valve
E) mitral valve

2) When the ventricles contract, the bicuspid valve prevents blood from flowing from the:

A) left ventricle to the left atrium
B) right ventricle to the right atrium
C) right atrium to the left atrium
D) left atrium to the right atrium
E) left ventricle to the right ventricle

3) The tricuspid valve is located between the:

A) right ventricle and the pulmonary trunk
B) left ventricle and pulmonary artery
C) right atrium and right ventricle
D) right atrium and left atrium
E) left ventricle and aorta

4) Which one of the following is true concerning the lub-dub sounds of the heart:

A) the first sound is caused by the closing of the atrioventricular valves; the second sound is caused by closure of the semilunar valves
B) the first sound is caused by closure of the tricuspid valve; the second sound is caused by closure of the mitral valve
C) the first sound is caused by closure of the tricuspid valve; the second sound is caused by closure of the mitral valve
D) the first sound is caused by closure of the semilunar valves; the second sound is caused by closure of the atrioventricular valves

5) The bicuspid valve is normally closed:

A) when the ventricle is in diastole
B) when the atrium is contracting
C) when the ventricle is contracting
D) when the ventricle is in systole
E) by the movement of blood from the atrium to the ventricle

6) **True or False:** Systole occurs during the contraction of the ventricles.

7) **True or False:** During diastole, the bicuspid and tricuspid valves are closed.

Application Question:

Don has a heart murmur (an unusual sound during a heartbeat) in his left ventricle that produces a loud "gurgling" sound at the beginning of systole. Which valve is probably faulty? Describe what you believe is causing this sound.