The Islamic University, Najaf

College of Medical Techniques

Department of Radiology Techniques

Medical Physiology

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Lecture (4)

Physiology of circulatory system

Dr. Ahmed Hussein Zwamel

PhD in Physiology of Reproduction and Clinical Embryology

ahmed.hussein.ali@iunajaf.edu.iq

Lecture Objectives

By the end of this lecture, the students should be able to:

1) Describe the circulatory system.
2) Understand the functions of each part of the circulatory system.
3) Explain the mechanisms of pumping the blood by the heart.

Lecture Contents

- Physiology of circulatory system
    - Physical characteristics of the circulation
    - Functional parts of the circulation
- Blood flow
- Heart anatomy
- The Heart Valves
- Heart as a pump

Physiology of circulatory system

The function of the circulation is to serve the needs of the body tissues, in general, to maintain an appropriate environment in all the tissue fluids of the body for survival and optimal function of the cells. The rate of blood flow through many tissues is controlled mainly in response to their need for nutrients.

Physical characteristics of the circulation

The circulation, shown in **Figure 1**, is divided into the **systemic circulation** and the **pulmonary circulation.** The systemic circulation supplies blood flow to all the tissues of the body except the lungs, it is also called the **greater circulation** or **peripheral circulation.** It is begun when the left ventricle pumps the oxygenated blood to the aorta and then to the arteries, and it is end when the non-oxygenated blood return to the right atrium of the heart through the veins. The pulmonary circulation begun when the right ventricle pumps the non-oxygenated blood to the lungs through the pulmonary artery and it is end when the oxygenated blood return to the left atrium of the heart.

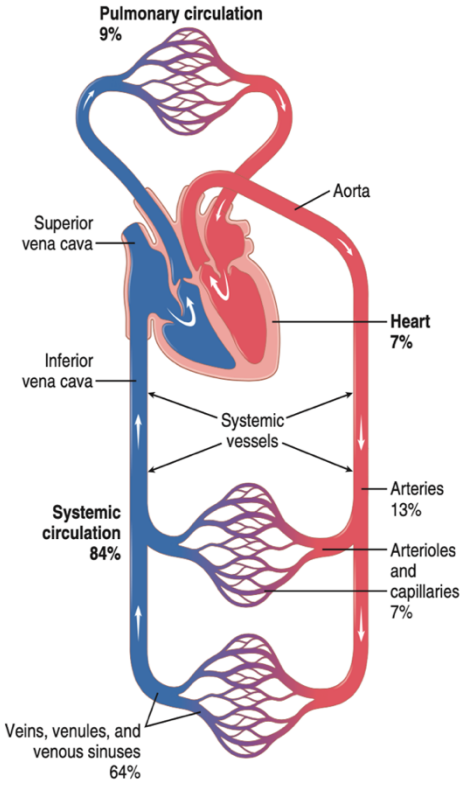

Figure 1: Distribution of blood in the different parts of the circulatory system.

Functional parts of the circulation.

The function of the **arteries** is to transport blood under high pressure to the tissues. For this reason, the arteries have strong vascular walls, and blood flows at a high velocity in the arteries.

The **arterioles** are the last small branches of The function of the **capillaries** is to exchange fluid, nutrients, electrolytes, hormones, and other substances between the blood and the interstitial fluid. To serve this role, the capillary walls are thin and have numerous minute **capillary pores** permeable to water and other small molecular substances.

The **venules** collect blood from the capillaries and gradually coalesce into progressively larger veins**.**

The **veins** function as conduits for transport of blood from the venules back to the heart; equally important, they serve as a major reservoir of extra blood. Because the pressure in the venous system is very low, the venous walls are thin. Even so, they are muscular enough to contract or expand and thereby serve as a controllable reservoir for the extra blood, either a small or a large amount, depending on the needs of the circulation.

Blood flow

Blood flow means the quantity of blood that passes a given point in the circulation in a given period of time. The overall blood flow in the total circulation of an adult person at rest is about **5000 ml/min**. This is called the **cardiac output** because it is the amount of blood pumped into the aorta by the heart each minute.

Heart anatomy

The heart is located between the lungs in the middle of chest, behind and slightly to the left of the breastbone (sternum). A double-layered membrane called the **pericardium** surrounds the heart like a sac. The outer layer of the pericardium surrounds the roots of the heart's major blood vessels and is attached by ligaments to the spinal column, diaphragm, and other parts of the body. The inner layer of the

pericardium is attached to the heart muscle. A coating of fluid separates the two layers of membrane, letting the heart move as it beats.

The heart weighs between 200 to 425 grams and is a little larger than the size of the fist. By the end of a long life, a person's heart may have beat (expanded and contracted) more than 3.5 billion times. In fact, each day, the average heart beats 100,000 times, pumping about 7,571 liters of blood.

The heart has 4 chambers. The upper chambers are called the left and right **atria**, and the lower chambers are called the left and right **ventricles**. A wall of muscle called the **septum** separates the left and right atria and the left and right ventricles. The left ventricle is the largest and strongest chamber in the heart. The left ventricle's chamber walls are only about a half-inch thick, but they have enough force to push blood through the aortic valve and into the body.

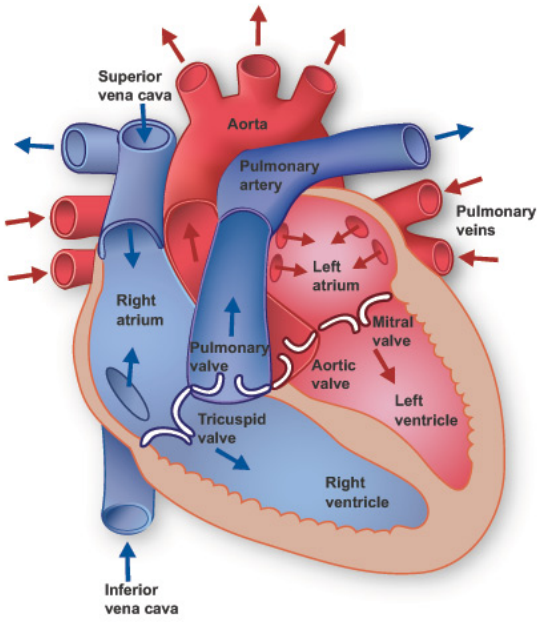

Figure 2: Heart anatomy.

The Heart Valves

Four valves regulate blood flow through the heart:

- The **tricuspid valve** regulates blood flow between the right atrium and right ventricle.
- The **pulmonary valve** controls blood flow from the right ventricle into the pulmonary arteries, which carry blood to the lungs to pick up oxygen.

- The **mitral valve** lets oxygen-rich blood from the lungs pass from the left atrium into the left ventricle.
- The **aortic valve** opens the way for oxygen-rich blood to pass from the left ventricle into the aorta, body's largest artery.

Heart as a pump

The heart, shown in Figure 3, is actually two separate pumps: a right heart that pumps blood through the lungs, and a left heart that pumps blood through the systemic circulation that provides blood flow to the other organs and tissues of the body. In turn, each of these hearts is a pulsatile two-chamber pump composed of an **atrium** and a **ventricle**. Each atrium is a weak primer pump for the ventricle, helping to move blood into the ventricle. The ventricles then supply the main pumping force that propels the blood either (1) through the pulmonary circulation by the right ventricle or (2) through the systemic circulation by the left ventricle.

Special mechanisms in the heart cause a continuing succession of heart contractions called **cardiac rhythmicity**, transmitting action potentials throughout the cardiac muscle to cause the heart's rhythmical beat.

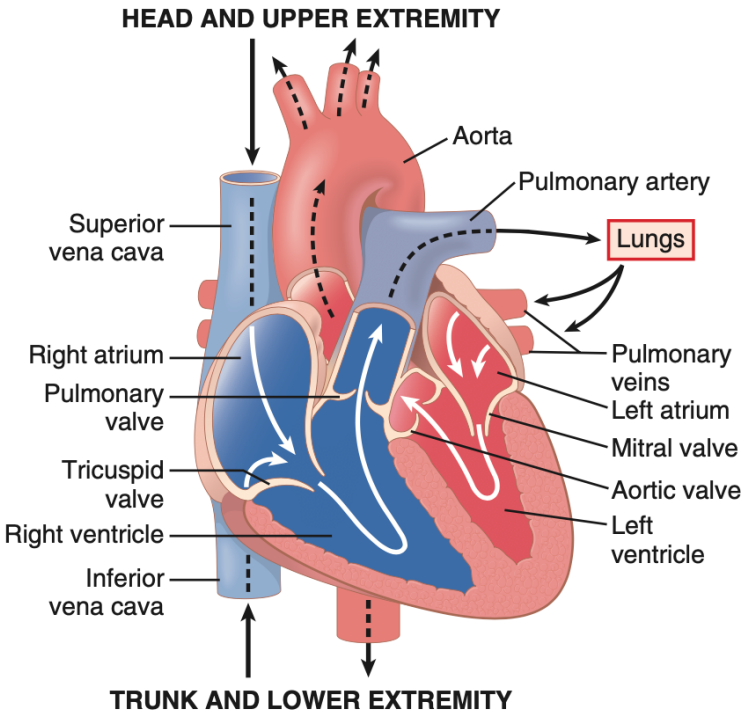

Figure 3: Heart as a pump