Tikrit University
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cardiovascular system

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cardiovascular system:

Functions of the cardiovascular system:

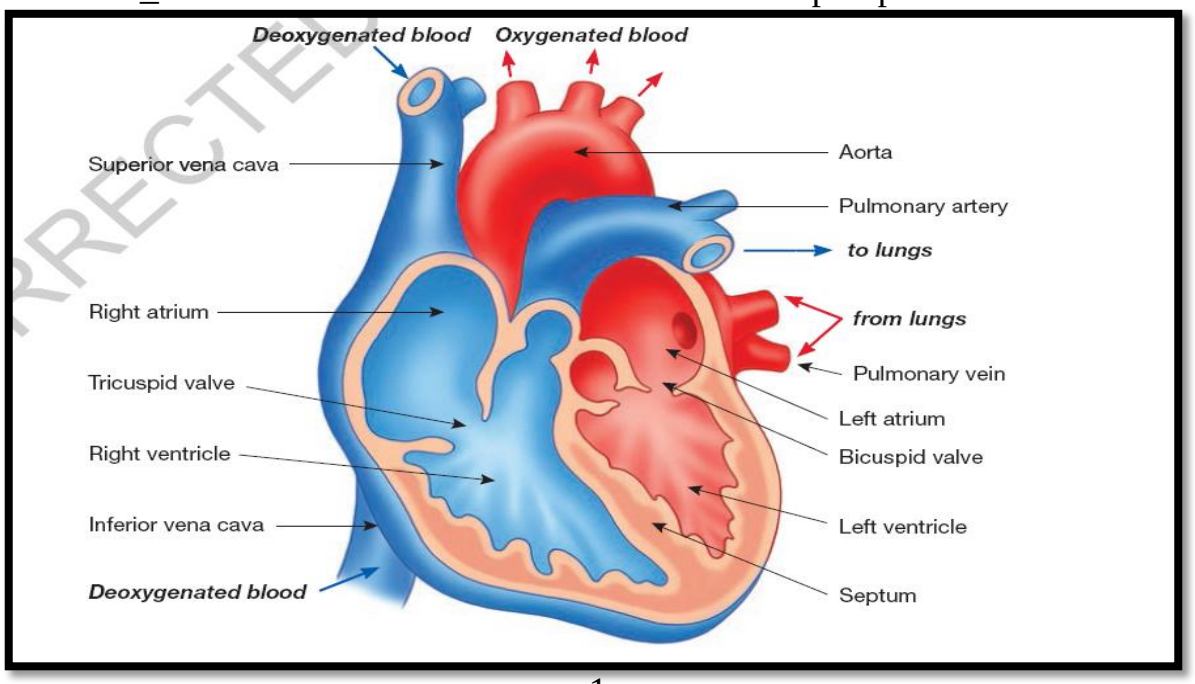
The body depends on the efficient functioning of the cardiovascular system. The cardiovascular system consists of the heart and blood vessels working together to transport gases and nutrients around the body. This system has five important functions:

1. It circulates blood to all parts of the body.
2. It transports water, oxygen and nutrients to the cells.
3. It transports wastes including carbon dioxide away from the cells.
4. It helps maintain correct body temperature.
5. It helps fight disease through the white blood cells and antibodies contained in the blood.

Structure of the heart

The heart is a pump designed to circulate blood throughout the cardiovascular system. The heart has four chambers — two atria and two ventricles.

- _ The atria are the upper chambers that receive blood.
- _ The ventricles are the lower chambers that pump blood.



Valves are located between the atria and the ventricles, and at the 3entrance to the arteries from the heart. The bicuspid valve is on the left side of the heart and the tricuspid valve is on the right side. They allow blood to travel in only one direction, stopping blood in the ventricles from flowing back into the atria.

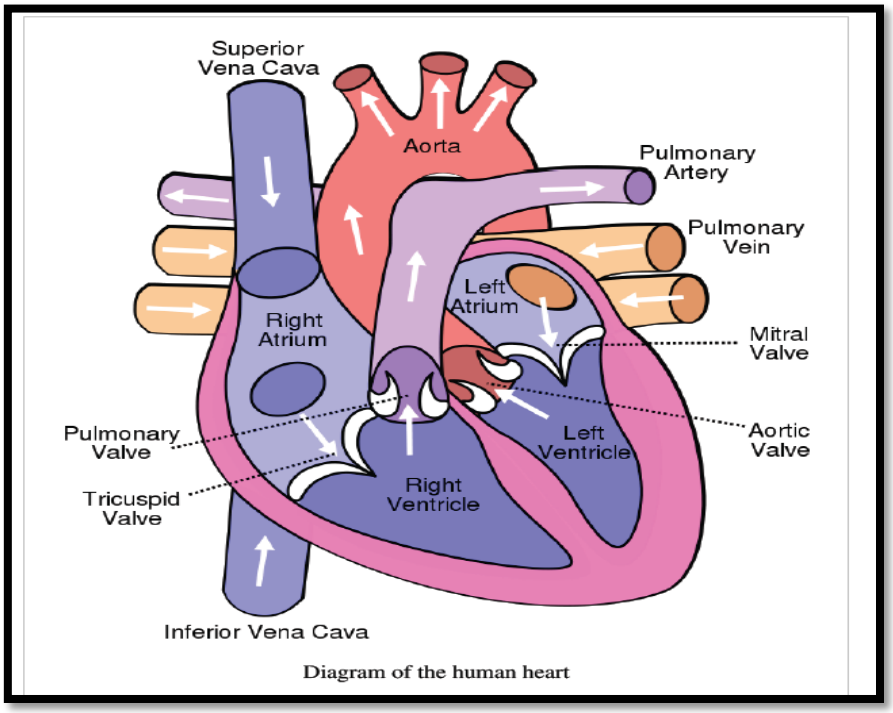


Diagram of the human heart

Blood vessels

In addition to the heart, the cardiovascular system has three types of blood vessels that control the direction and volume of the blood flow around the body:

_ Arteries.

_ Veins.

_ Capillaries.

This network is also referred to as the vascular system.

ARTERIES and ARTERIOLES

1. Arteries carry blood **from** the heart to the capillaries of the organs in the body.

2. The walls of arteries are **thicker** than those of veins. The smooth muscle and elastic fibers that make up their walls enable them to withstand the high pressure of blood as it is pumped from the heart. The force that blood exerts on the walls of blood vessels is known as **blood pressure** and it cycles with each heart-beat.

3. Each artery **expands** when the pulse of blood passes through and **the elastic recoil** الارتداد المرنof the fibers cause it to **spring back** afterwards, thus helping the blood along. This is known as **secondary circulation**, and it reduces the load on the heart.

4. Other than the **pulmonary arteries, all** arteries carry oxygenated blood.

5. The **aorta** carries oxygenated blood from the **left ventricle** to all parts of the body **except** the lungs. It has the largest diameter (25mm) and carries blood at the highest pressure.

6. As the aorta travels away from the heart, it branches into smaller arteries so that all parts of the body are supplied. The smallest of these are called arterioles.

7. Arterioles can **dilate** or **constrict** to alter their diameter and so alter the flow of blood through the organ supplied by that arteriole. Examples include muscles (when running) and skin (when hot or blushing).

8. Two organs which **always** have the same blood flow are the brain and the kidneys. Popular organs to have blood flow reduced are the guts (between meals), muscles (when resting) and skin (when cold).

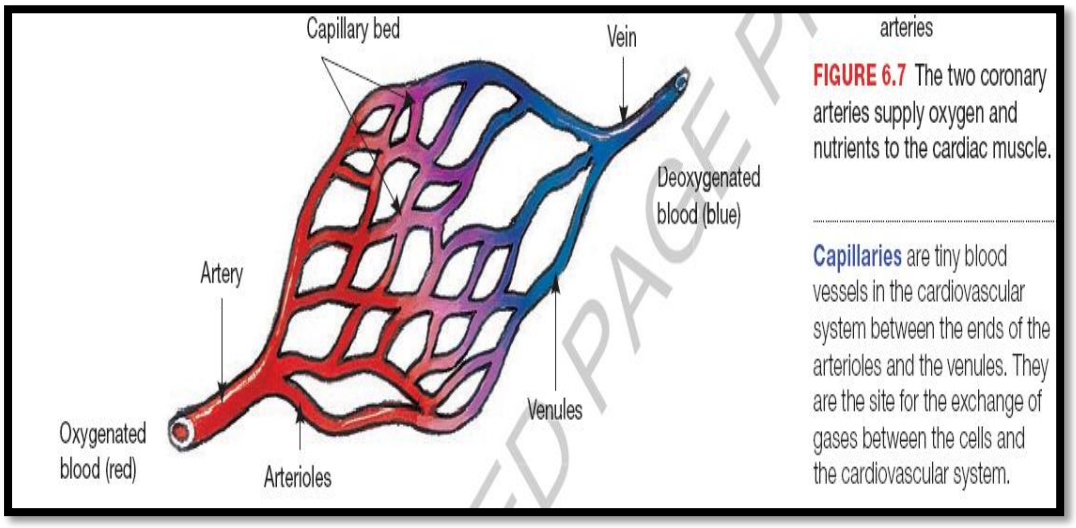
CAPILLARIES

1. Arterioles branch into networks of very small blood vessels – the capillaries. These have a **very large surface** area and **thin walls** that is only one (epithelial) cell thick.

2. It is in the capillaries that exchanges take place between the blood and the tissues of the body.

3. Capillaries are also **narrow**. This **slows the blood down** allowing time for diffusion to take occur. In most capillaries, blood cells must flow in single file دفعة واحدة.

4. **Tissue fluid** is formed in the capillaries, for their walls are leaky



A long-term exercise program may increase the number of capillaries supplying blood to muscles (including the heart). This allows an increased supply of oxygen and other nutrients to the muscles and a more rapid removal of wastes. The capillaries eventually carry these wastes to the venules, which then carry them into the veins.

Veins

Veins carry blood to the heart. The pulmonary veins will carry oxygenated blood to the heart, while the systemic veins will carry

deoxygenated to the heart. Most of the blood volume is found in the venous system; about 70% at any given time. The veins outer walls have the same three layers as the arteries, differing only because there is a lack of smooth muscle in the inner layer and less connective tissue on the outer layer. Veins have low blood pressure compared to arteries and need the help of skeletal muscles to bring blood back to the heart. Most veins have one-way valves called venous valves to prevent backflow caused by gravity. They also have a thick collagen outer layer, which helps maintain blood pressure and stop blood pooling. The hollow internal cavity in which the blood flows is called the lumen. A muscular layer allows veins to contract, which puts more blood into circulation.

Veins are used medically as points of access to the blood stream, permitting the withdrawal of blood specimens (venipuncture) for testing purposes, and enabling the infusion of fluid, electrolytes, nutrition, and medications (intravenous delivery).

Blood circulation:

Circulation of blood throughout the body is divided into two closed circuits:

1. **systemic circulation**: when oxygenated (oxygen-rich) blood is transported from the heart via the left ventricle and aorta and circulated into the arteries around the body (except for the lungs), and deoxygenated (oxygen-poor) blood returns to the heart via the vena cava الوريد الجوفand into the right atrium.
2. **pulmonary circulation**: when deoxygenated blood is transported away from the heart and circulated to the lungs via the right ventricle and pulmonary artery, and oxygenated blood returns to the heart via the pulmonary vein and into the left atrium.

- **The following sequence shows how blood is circulated through the body:**

1. The right atrium receives blood (low in oxygen and high in carbon dioxide) from the body via the vena cava.
2. The right ventricle receives blood from the right atrium via the tricuspid valve and pumps this blood to the lungs via the pulmonary artery.

3. Blood gives up carbon dioxide and takes up oxygen while in the lungs.

4. Oxygenated blood returns via the pulmonary vein to the left atrium.

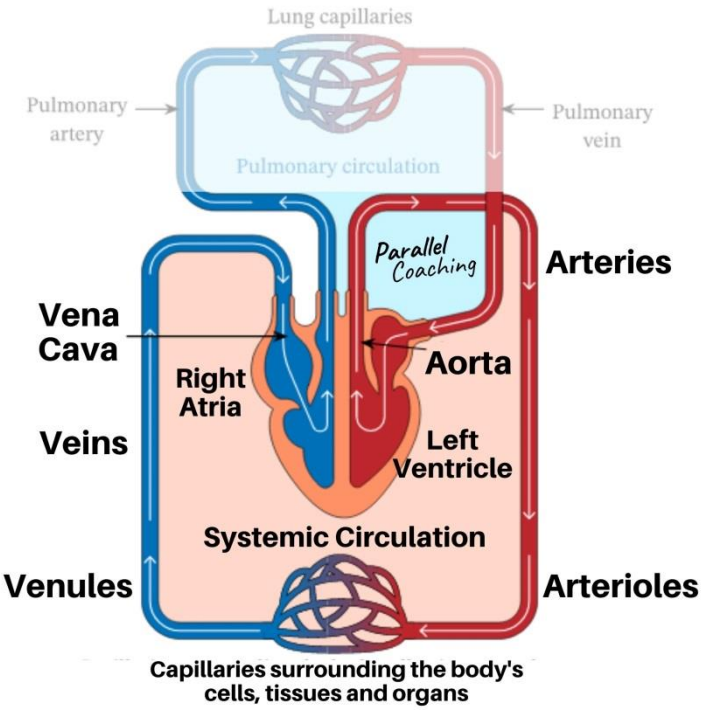
Blood enters the left ventricle via the bicuspid valve and is pumped through the aorta into the arterial system.

6. Blood flows to all extremities of the body through the arterioles.

7. Blood enters capillaries, where oxygen and nutrients are fed to the cells, and carbon dioxide, water and other wastes are removed from the cells.

8. Capillaries carry blood to the venues, then to the veins.

9. Veins return oxygen-poor blood to the right atrium.



Cardiac conduction

Cardiac conduction is the rate at which the heart conducts electrical impulses. These impulses cause the heart to contract and then relax. The constant cycle of heart muscle contraction followed by relaxation causes blood to be pumped throughout the body. The conduction pathway is made up of five elements:

1. the Sino-atrial (SA) node,
2. the atrioventricular (AV) node,
3. the bundle of His,
4. the left and right bundle branches,
5. the Purkinje fibers.

• SA node

The SA node is the natural pacemaker of the heart, which is in the right atrium. The SA node is a spindle-shaped structure composed of a fibrous tissue matrix with closely packed cells. The SA node releases electrical stimuli at a regular rate.

The needs of the body dictate the rate. Each stimulus passes through the atria's myocardial cells, creating a wave of contraction that spreads rapidly through both atria. The heart is made up of around half a billion cells. Most of the cells make up the ventricular walls. The rapidity of atrial contraction is that approximately 100 million myocardial cells contract in less than one-third of a second.

• AV node

The AV node lies on the right side of the partition that divides the atria, near the bottom of the right atrium.

When the impulses from the SA node reach the AV node, they are delayed for about a tenth of a second. This delay allows the atria to contract and empty their contents first. The AV node regulates the signals to the ventricles to prevent rapid conduction (atrial fibrillation) and make sure that the atria are empty and closed before stimulating the ventricles.

• Bundle of His

His bundle is a collection of heart muscle cells specialized for electrical conduction that transmits the electrical impulses from the AV node to the point of the apex of the fascicular branches. This bundle is the only site where action potential can conduct from the atria to the ventricles.

Left and right bundle branches

This is a segment of the network of specialized conducting fibers that transmit electrical impulses within the heart's ventricles.

Bundle branches continue the atrioventricular (AV) bundle, which extends from the upper part of the intraventricular septum. The AV

bundle divides into a left and a right branch, each going to its respective ventricle by passing down the septum and beneath the endocardium. Within the ventricles, the bundle branches subdivide and terminate in the Purkinje fibers.

• Purkinje fibers

These fibers are in the inner ventricular walls of the heart. These fibers consist of specialized cardiomyocytes that can conduct cardiac action potentials more quickly and efficiently than any other cells in the heart. Purkinje fibers allow the heart's conduction system to create synchronized contractions of its ventricles and are essential for maintaining a consistent heart rhythm.

Blood pressure:

Blood pressure is an indicator of the body's health. It shows:

1. How hard the heart has to work to push the blood through the arteries, capillaries and veins.
2. The health of the arteries and capillaries.

Blood pressure has two measurements: an upper reading called the systolic blood pressure, and a lower reading called the diastolic blood pressure.

_ Systolic blood pressure is a measure of the pressure that the blood exerts against the artery walls during the contractile (emptying) stage of the heart's pumping.

_ Diastolic blood pressure is a measure of the same pressure against the artery walls, but during the relaxation (filling) phase of the heart's pumping action. Ameans millimetres of mercury, referring to the mercury-based device that measures blood pressure (sphygmomanometer

Many factors affect systolic blood pressure.

As a general rule, it should not be more than 140 mm Hg while at rest. Values above 140 mm Hg signify hypertension or high blood pressure.

This is of concern as the heart has to work harder to pump blood around the body due to the increased pressure in the vessel walls. People with hypertension are at greater risk of developing cardiovascular diseases.

A guideline for predicting healthy systolic blood pressure is 100 plus your age, with a recommended maximum of 140–50 However, with a healthy and active lifestyle, older people could sustain a systolic blood pressure of around 120 mm Hg.

Regular exercise usually helps keep systolic blood pressure below the averages for 40–60 year olds.

Animal	Heart Rate (beats/minute)
Horse	32 - 44
Horse (thuroughbred)	38 - 48
Dairy cow	60 - 70
Sheep & Goat	70 - 80
Pig	60 - 80
Dog	70 - 120
Cat	110 - 130
Chicken	200 - 400
Human	60 - 90