# Chapter III. THE CIRCULATORY SYSTEM

## Vertebrats

### 1. Introduction :

The circulatory system, also called the cardiovascular system, is the organ system that transports materials to and from all the cells of the body. The materials carried by the cardiovascular system include oxygen from the lungs, nutrients from the digestive system, hormones from glands of the endocrine system, and waste materials from cells throughout the body. Transport of these and many other materials is necessary to maintain homeostasis of the body.

### 2.Human Circulatory System :

The human circulatory system consists of a network of arteries, veins, and capillaries, with the heart pumping blood through it. Its primary role is to provide essential nutrients, minerals, and hormones to various parts of the body. Alternatively, the circulatory system is also responsible for collecting metabolic waste and toxins from the cells and tissues to be purified or expelled from the body.

### 3.Features of Circulatory System :

The crucial features of the human circulatory system are as follows:

- The human circulatory system consists of blood, heart, blood vessels, and lymph.
- The human circulatory system circulates blood through two loops (double circulation) : – One for oxygenated blood, another for deoxygenated blood.
- The human heart consists of four chambers – two ventricles and two auricles.
- The human circulatory system possesses a body-wide network of blood vessels. These comprise arteries, veins, and capillaries.
- The primary function of blood vessels is to transport oxygenated blood and nutrients to all parts of the body. It is also tasked with collecting metabolic wastes to be expelled from the body.

### 4.Organs of Circulatory System :

The human circulatory system comprises 4 main organs that have specific roles and functions. The vital circulatory system organs include:

- Heart
- Blood (technically, blood is considered a tissue and not an organ)
- Blood Vessels
- Lymphatic system

#### 1.Heart :

The heart is a muscular organ located in the chest cavity, right between the lungs. It is positioned slightly towards the left in the thoracic region and is enveloped by the pericardium. The human heart is separated into four chambers; namely, two upper chambers called atria **atrium** , and two lower chambers called **ventricles**.

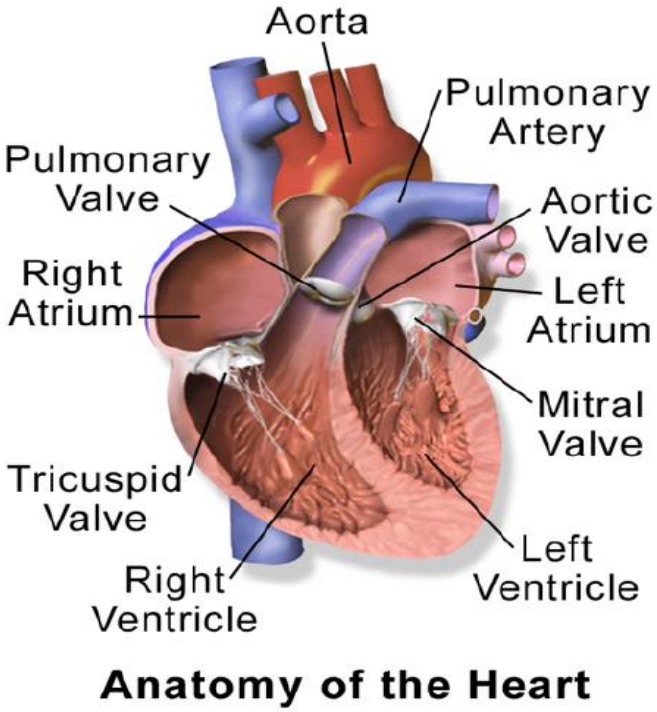


**Figure 1 : Anatomy of the heart**

**2.Blood :**

Blood is the body's fluid connective tissue, and it forms a vital part of the human circulatory system. Its main function is to circulate nutrients, hormones, minerals and other essential components to different parts of the body. Blood flows through a specified set of pathways called blood vessels. The organ which is involved in pumping blood to different body parts is the heart. Blood cells, blood plasma, proteins, and other mineral components (such as sodium, potassium and calcium) constitute human blood.
Blood is composed of:

**Plasma,** the fluid part of the blood and is composed of 90% of water.
**Red blood cells,** white blood cells and platelets constitute the solid part of blood.

**Types of Blood Cells :**

The human body consists of three types of blood cells, namely:

A. **Red blood cells (RBC) / Erythrocytes :** Red blood cells are mainly involved in transporting oxygen, nutrients, and other substances to various parts of the body. These blood cells also remove waste from the body.

B. **White blood cells (WBC) / Leukocytes :** White blood cells are specialized cells, which function as a body's defence system. They provide immunity by fending off pathogens and harmful microorganisms.

C. **Platelets / Thrombocytes :** Platelets are cells that help to form clots and stop bleeding. They act on the site of an injury or a wound.

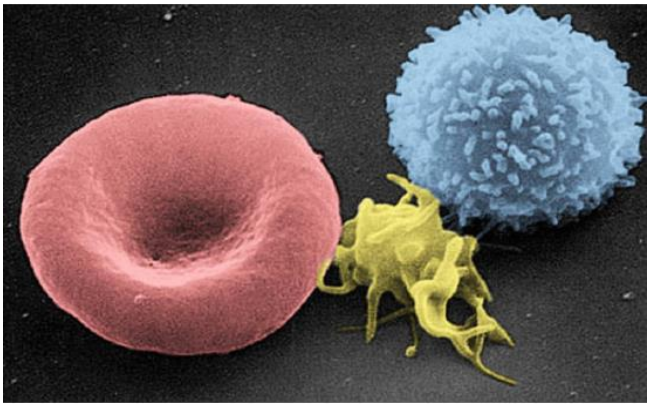

**Figure 2 : The three types of cells in the blood are pictured here: red blood cell (left), platelet (center), and white blood cell (right).**

## 3.Blood Vessels :

Blood vessels are a network of pathways through which blood travels throughout the body :

**Arteries** (carry blood away from the heart)

• Also called efferent vessels

**Veins** (carry blood to the heart)

• Also called afferent vessels

**Capillaries** (exchange substances between blood and tissues)

• Interconnect smallest arteries and smallest veins.

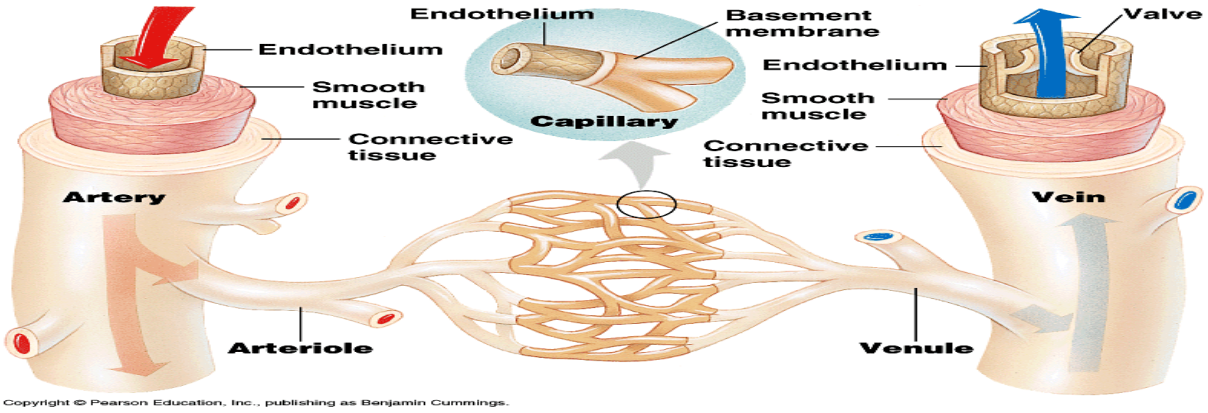


**Figure 3: Blood Vessels**

### 4. Lymphatic System :

The human circulatory system consists of another body fluid called lymph. It is also known as tissue fluid. It is produced by the lymphatic system which comprises a network of interconnected organs, nodes and ducts.

Lymph is a colourless fluid consisting of salts, proteins, water, which transport and circulates digested food and absorbed fat to intercellular spaces in the tissues. Unlike the circulatory system, lymph is not pumped; instead, it passively flows through a network of vessels.

## 5.Functions of Circulatory System :

The most important function of the circulatory system is transporting oxygen throughout the body. The other vital functions of the human circulatory system are as follows:

**1.**It helps in sustaining all the organ systems.

**2.**It transports blood, nutrients, oxygen, carbon dioxide and hormones throughout the body.

**3.**It protects cells from pathogens.

**4.**It acts as an interface for cell-to-cell interaction.

**5.**The substances present in the blood help repair the damaged tissue.

### 6.Two Circulations :

Cells throughout the body need a constant supply of oxygen. They get oxygen from capillaries in the systemic circulation. The systemic circulation is just one of two interconnected circulations that make up the human cardiovascular system. The other circulation is the pulmonary system. This is where the blood picks up oxygen to carry to cells. It takes blood about 20 seconds to make one complete transit through both circulations.

### 6.1.Pulmonary Circulation :

The pulmonary circulation involves only the heart and lungs and the major blood vessels that connect them.

Blood moves through the pulmonary circulation from the heart to the lungs, and back to the heart again, becoming oxygenated in the process. Specifically, the right ventricle of the heart pumps deoxygenated blood into the right and left pulmonary arteries. These arteries carry the blood to the right and left lungs, respectively. Oxygenated blood then returns from the right and left lungs through the two right and two left pulmonary veins. All four pulmonary veins enter the left atrium of the heart.

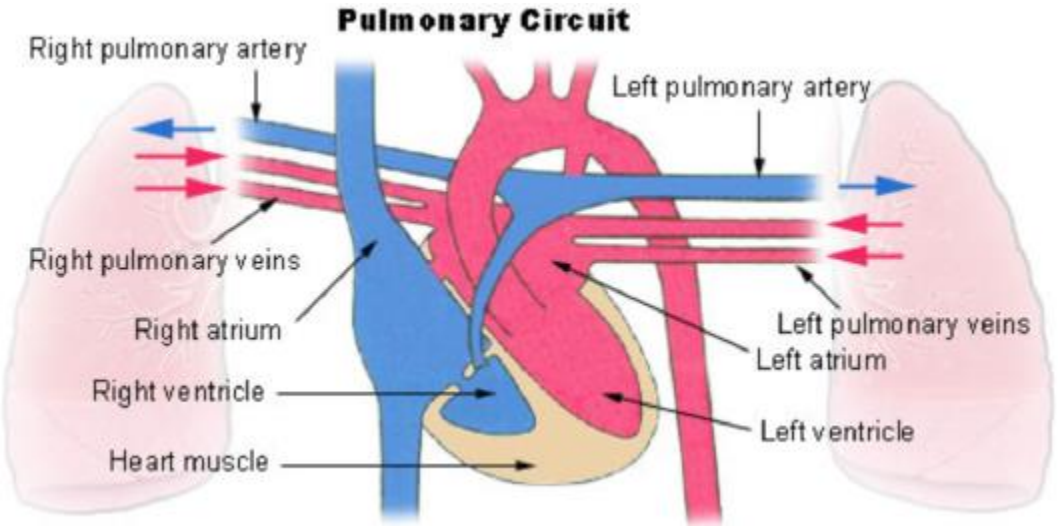


**Figure 4 :** This diagram shows the heart, lungs, and major vessels that make up the pulmonary circulation. The colored arrows indicate the direction of blood flow. Oxygenated blood (in red) flows from the lungs to the left side of the heart. Deoxygenated blood (in blue) flows from the right side of the heart to the lungs.

### 6.2. Systemic Circulation :

The oxygenated blood that enters the left atrium of the heart in the pulmonary circulation then passes into the systemic circulation. This is the part of the cardiovascular system that transports blood to and from all of the tissues of the body to provide oxygen and nutrients and pick up wastes. It consists of the heart and blood vessels that supply the metabolic needs of all the cells in the body, including those of the heart and lungs.

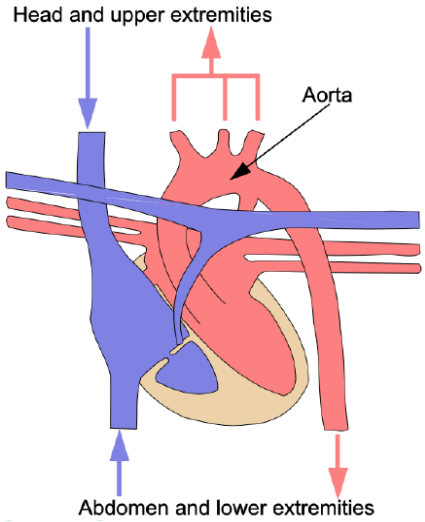


**Figure 5 :** The systemic circulation includes the aorta (red), which carries oxygenated blood away from the heart to the rest of the body; and the inferior and superior venae cavae (blue), which return deoxygenated blood to the heart from the body. The colored arrows in the diagram indicate the direction of blood flow, red for oxygenated and blue for deoxygenated.