

CONTENT

Preface.....	iv
Introductory Notes to Students.....	vi
List of Heads of Department (Past and Present).....	ix
List of Anatomy Instructors Academic staff.....	x
University Examinations Regulations.....	xiii
Chapter 1: General Anatomy.....	1-11
Chapter 2: Microscopic Techniques.....	12-21
Chapter 3: General Embryology.....	22-29
Chapter 4: Genetics.....	30-39
Chapter 5: Respiratory System.....	40-51
Chapter 6: Cardiovascular System.....	52-59
Chapter 7: Gastrointestinal System.....	60-72
Chapter 8: Digestive System.....	73-87
Chapter 9: Reproductive System and Perineum.....	88-98
Chapter 10: Urinary System.....	99-107
Chapter 11: Upper Limbs.....	108-134
Chapter 12: Lower Limbs.....	135-153
Chapter 13: Head and Neck.....	154-164
Chapter 14: Neuroanatomy.....	165-179
Chapter 15: Radiological Anatomy.....	180-189
Chapter 16: Histochemistry and Cytochemistry.....	190-194

CARDIOVASCULAR SYSTEM

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Outline

- Introduction to the cardiovascular system
- Blood vessel
- Coronary circulation
- Introduction to embryology of the heart
- The lymphatic system
- Case study
- SAQ
- MCQ

INTRODUCTION TO THE CARDIOVASCULAR SYSTEM

- The cardiovascular system (CVS) consists of the heart (Fig. 6.1), blood vessels, and the approximately 5 liters of blood that circulates the body through blood vessels.
- The CVS is powered by the heart, which is only about the size of a clenched fist. The heart is a vital organ in the body; responsible for the circulation of blood throughout the body.
- The heart is a muscular pump located in the middle mediastinum of the thoracic cavity.
- The apex of the heart is directed to the left, so that about $\frac{2}{3}$ of the heart is located to the left of the median plane, while the other $\frac{1}{3}$ lies to the right.
- The anatomical base of the heart is formed by the atria,
- The heart is divisible into four chambers: two (right and left) ventricles and two (right and left) atria.
- Histologically, the heart consists of cardiac muscle cell; these are cylindrical striated cells that are linked with one another by intercalated discs

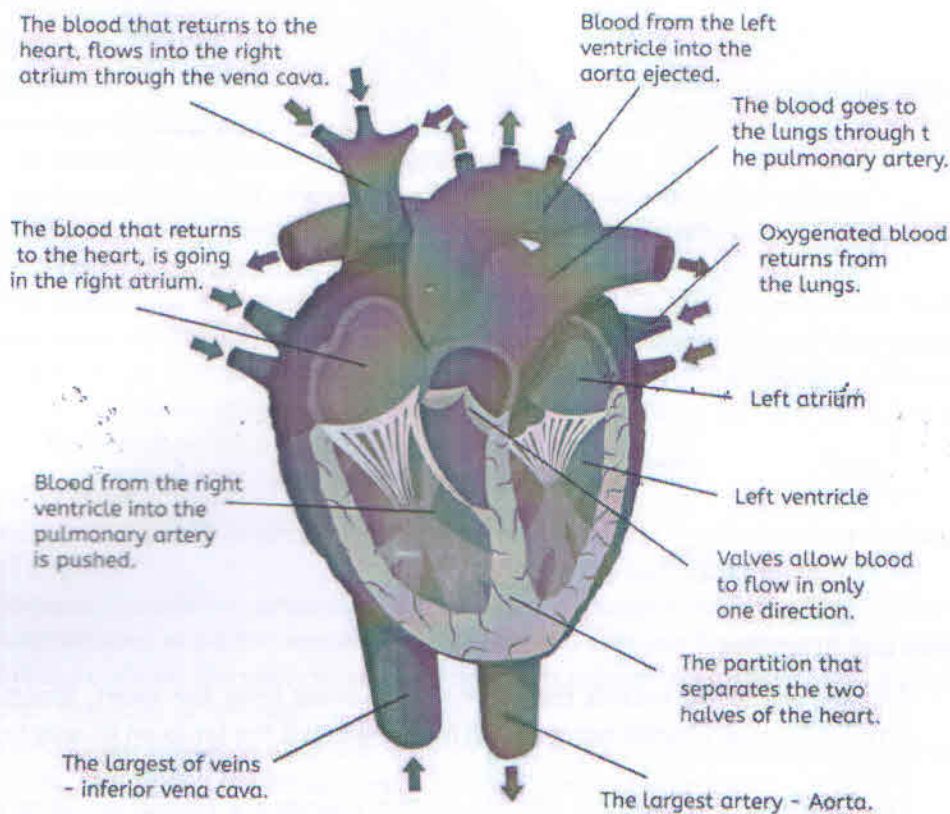


Figure 6.1 Schematic diagram of the heart.

BLOOD VESSELS

- Blood vessels are the body's highways that allow blood to flow quickly and efficiently from the heart to every region of the body and back again.
- The size of blood vessels corresponds with the amount of blood that passes through the vessel. All blood vessels contain a hollow area called the lumen through which blood is able to flow. Around the lumen is the wall of the vessel, which may be thin in the case of capillaries or very thick in the case of arteries.
- All blood vessels are lined with a thin layer of simple squamous epithelium known as the endothelium that keeps blood cells inside of the blood vessels and prevents clots from forming. The endothelium lines the entire circulatory system, all the way to the interior of the heart, where it is called the endocardium.
- Blood vessels are often named after either the region of the body through which they carry blood or for nearby structures. For example, the brachiocephalic artery carries blood into the brachial (arm) and cephalic (head) regions.

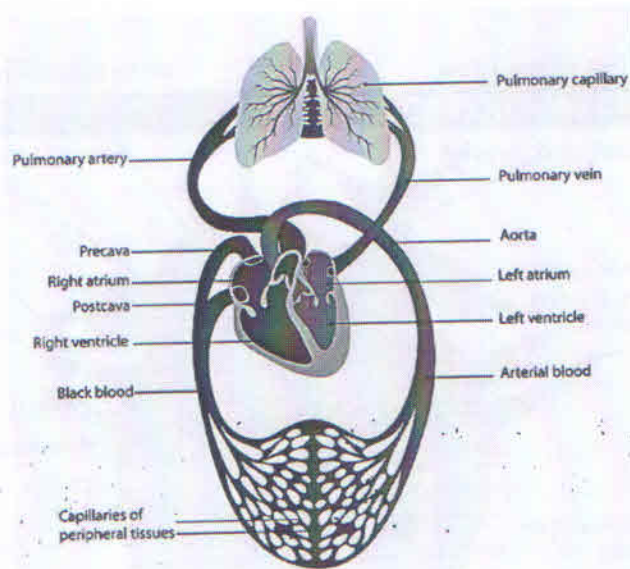


Figure 6.2: The circulatory system

Arteries and Arterioles

- Arteries are blood vessels that carry blood away from the heart. Blood carried by arteries is usually highly oxygenated, having just left the lungs on its way to the body's tissues.
- The pulmonary trunk and arteries of the pulmonary circulation loop provide an exception to this rule – these arteries carry deoxygenated blood from the heart to the lungs to be oxygenated.
- Arteries face high levels of blood pressure as they carry blood being pushed from the heart under great force. To withstand this pressure, the walls of the arteries are thicker, more elastic, and more muscular than those of other vessels.
- The largest arteries of the body contain a high percentage of elastic tissue that allows them to stretch and accommodate the pressure of the heart. Smaller arteries are more muscular in the structure of their walls. The smooth muscles of the arterial walls of these smaller arteries contract or expand to regulate the flow of blood through their lumen. In this way, the body controls how much blood flows to different parts of the body under varying circumstances.
- The regulation of blood flow also affects blood pressure, as smaller arteries give blood less area to flow through and therefore increases the pressure of the blood on arterial walls.
- Arterioles are narrower arteries that branch off from the ends of arteries and carry blood to capillaries. They face much lower blood pressures than arteries due to their greater number, decreased blood volume, and distance from the direct pressure of the heart.
- Thus, arteriole walls are much thinner than those of arteries. Arterioles, like arteries

are able to use smooth muscle to control their aperture and regulate blood flow and blood pressure.

Capillaries

- Capillaries are the smallest and thinnest of the blood vessels in the body and also the most common. They can be found running throughout almost every tissue of the body and border the edges of the body's avascular tissues.
- Capillaries connect to arterioles on one end and venules on the other.
- Capillaries carry blood very close to the cells of the tissues of the body in order to exchange gases, nutrients, and waste products.
- The walls of capillaries consist of only a thin layer of endothelium so that there is the minimum amount of structure possible between the blood and the tissues. The endothelium acts as a filter to keep blood cells inside of the vessels while allowing liquids, dissolved gases, and other chemicals to diffuse along their concentration gradients into or out of tissues.

Veins and Venules

- Veins are the large return vessels of the body and act as the blood-return counterparts of arteries.
- Because the arteries, arterioles, and capillaries absorb most of the force of the heart's contractions, veins and venules are subjected to very low blood pressures. This lack of pressure allows the walls of veins to be much thinner, less elastic, and less muscular than the walls of arteries.
- Venules are similar to arterioles as they are small vessels that connect capillaries, but unlike arterioles, venules connect to veins instead of arteries.
- Venules pick up blood from many capillaries and deposit it into larger veins for transport back to the heart.
- Veins rely on gravity and the force of skeletal muscle contractions to help push blood back to the heart. To facilitate the movement of blood, some veins contain many one-way valves that prevent blood from flowing away from the heart. As skeletal muscles in the body contract, they squeeze nearby veins and push blood through valves closer to the heart.

CORONARY CIRCULATION

- The heart has its own set of blood vessels that provide the myocardium with the oxygen and nutrients necessary to pump blood throughout the body.
- The left and right coronary arteries branch off from the aorta and provide blood to the left and right sides of the heart.
- The coronary sinus is a vein on the posterior side of the heart that returns deoxygenated blood from the myocardium to the vena cava.

INTRODUCTION TO EMBRYOLOGY OF THE HEART

- The heart's development begins in the third week of gestation and ends by the ninth week. Initially, a single tube is created with a venous and an arterial end. The heart tube comprises five separate areas in the following order: Truncus arteriosus, Bulbus

cordis, Primitive Ventricle, Primitive Atrium, and the Sinus Venosus (Figure 6.3A).

- Around the 22nd day of intrauterine life, cardiac looping commences due to the elongation of the cardiac tube, with both ends of the tube being fixed. The left-right polarity forms as the primitive ventricle bends into a loop, shifting anteriorly and to the right, while the caudal part of the tube curves upward, toward the head, and to the left (Figure 6.3B).
- By day 28, the heart consists of the common atrium, common ventricle, and common outflow tract (Figure 6.3C). During this period, blood is propelled from the distal end through the sinus venosus upwards to the truncus arteriosus.
- The development of the four-chambered heart with two outflow tracts involves the simultaneous formation of three septa that separate the atria, truncus arteriosus, and ventricles.
- The truncus arteriosus splits into the ascending aorta and pulmonary artery. The bulbus cordis forms part of the ventricles. The sinus venosus connects to the foetal circulation. Septa form within the atria and ventricles to separate the left and right sides of the heart. Defective septation could result in anomalous communication between heart chambers. Other congenital anomalies could involve the great vessels associated with the heart (e.g., tetralogy of Fallot)

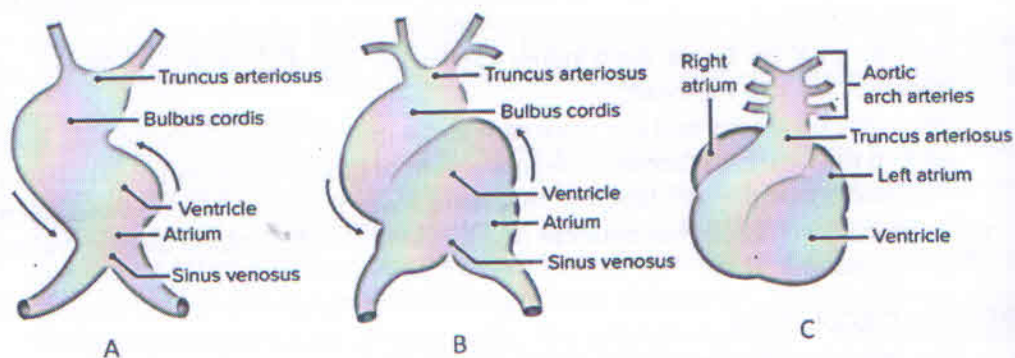


Figure 6.3 The development of the human heart

The Lymphatic system

- The lymphatic system is a network of vessels, nodes, and ducts that collect and circulate excess fluid in the body.
- The lymphatic system is closely associated with the circulatory system. It also maintains fluid balance and plays a role in absorbing fats and fat-soluble nutrients from the intestine.

- It allows the circulation of a fluid called lymph through the body in a similar way to blood. It is also an essential part of the immune system
- The lymphatic system is essential for fluid balance, absorption of fatty acids in the stomach, and immune system regulation.

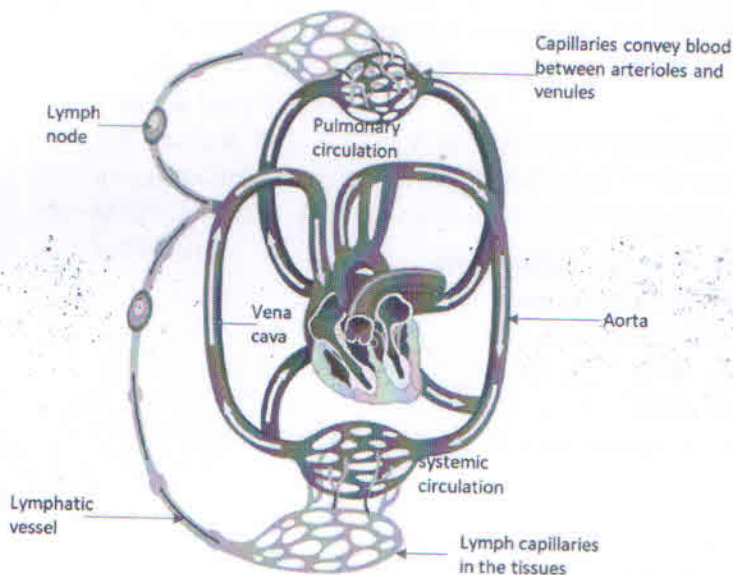


Figure 6.4 The Lymphatic system

CASE STUDY

Baby VJ, a 2-week-old baby neonatal presented to the intensive care unit with complaints of bluish colouration of the skin, lips and nails whenever the baby is feeding. This makes the baby very irritable and fussy. On examination of the chest, a loud murmur was heard and the heartbeat was rapid. Supplemental oxygen was administered via nasal prongs but there was no improvement.

- What congenital anomaly of the heart could account for the symptoms and signs observed in the baby?
- What are the possible anatomical defects in the baby?
- What investigations can be done to make a definitive diagnosis?
- How can the condition be corrected?

SAQ

- With the aid of annotated illustrations ONLY, describe the anatomy of the lymphatic system.
- Write short notes on the chambers of the heart.

3. With the aid of a diagram, describe the layers of the heart wall

MCQ (1 in 5)

1. The base of the heart lies
 - a. Superior
 - b. Inferior
 - c. Anterior
 - d. Posterior**
 - e. Medial
2. Brachiocephalic veins form
 - a. Subclavian and internal jugular veins
 - b. Hemi-zygous and azygous veins
 - c. Brachial and cephalic veins
 - d. Inferior vena cava
 - e. Superior vena cava**
3. Which structure receives blood from the capillary bed
 - a. Capillary
 - b. Arteriole
 - c. Venule**
 - d. Elastic artery
 - e. Muscular artery
4. The following structures are part of systemic circulation **EXCEPT**
 - a. Aorta
 - b. Femoral vein
 - c. Superior vena cava
 - d. Pulmonary vein**
 - e. Renal artery
5. One of the following is a feature of lymphatic capillaries
 - a. located in the spaces between cells in all parts of the body
 - b. highly permeable vessels**
 - c. cannot be found near blood capillaries
 - d. rarely seen in the loose areolar connective tissue
 - e. they are closed at both ends

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