VISWASS SCHOOL & COLLEGE OF NURSING

GNM 1ST YEAR

ANATOMY AND PHYSIOLOGY

UNIT-4

THE CIRCULATORY SYSTEM

LONG QUESTION AND ANSWER

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1.a)Explain the structure and physiology of the heart. (8+7)

b)Describe briefly about blood vessels and classify?

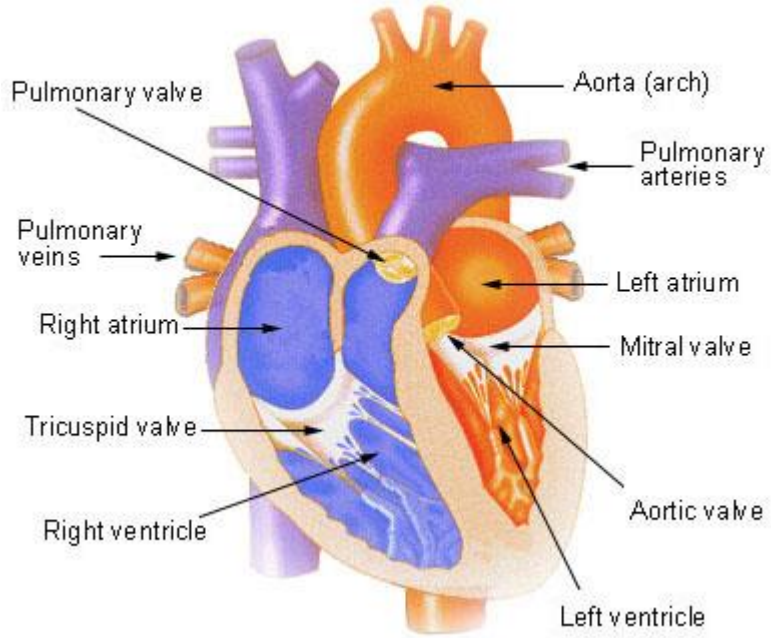
c)Structure & Physiology of the heart:

Structure of the heart:

The human heart is a four-chambered muscular organ, shaped and sized roughly like a man's closed fist with two-thirds of the mass to the left of midline.

The heart is enclosed in a pericardial sac that is lined with the parietal layers of a serous membrane. The visceral layer of the serous membrane forms the epicardium.

Internal View of the Heart



Layers of the Heart Wall

Three layers of tissue form the heart wall. The outer layer of the heart wall is the epicardium, the middle layer is the myocardium, and the inner layer is the endocardium.

Chambers of the Heart

The internal cavity of the heart is divided into four chambers:

- Right atrium
- Right ventricle
- Left atrium
- Left ventricle

➢ The two atria are thin-walled chambers that receive blood from the veins.

➢ The two ventricles are thick-walled chambers that forcefully pump blood out of the heart.

➢ Differences in thickness of the heart chamber walls are due to variations in the amount of myocardium present, which reflects the amount of force each chamber is required to generate.

- The right atrium receives deoxygenated blood from systemic veins; the left atrium receives oxygenated blood from the pulmonary veins.

Valves of the Heart

- Pumps need a set of valves to keep the fluid flowing in one direction and the heart is no exception.
- The heart has two types of valves that keep the blood flowing in the correct direction.
- The valves between the atria and ventricles are called atrioventricular valves (also called cuspid valves), while those at the bases of the large vessels leaving the ventricles are called semilunar valves.
- The right atrioventricular valve is the tricuspid valve.
- The left atrioventricular valve is the bicuspid, or mitral, valve.
- The valve between the right ventricle and pulmonary trunk is the pulmonary semilunar valve.
- The valve between the left ventricle and the aorta is the aortic semilunar valve.
- When the ventricles contract, atrioventricular valves close to prevent blood from flowing back into the atria.
- When the ventricles relax, semilunar valves close to prevent blood from flowing back into the ventricles.

Pathway of Blood through the Heart

- While it is convenient to describe the flow of blood through the right side of the heart and then through the left side, it is important to realize that both atria and ventricles contract at the same time.
- The heart works as two pumps, one on the right and one on the left, working simultaneously.
- Blood flows from the right atrium to the right ventricle, and then is pumped to the lungs to receive oxygen.
- From the lungs, the blood flows to the left atrium, then to the left ventricle.
- From there it is pumped to the systemic circulation.

Blood Supply to the Myocardium

- The myocardium of the heart wall is a working muscle that needs a continuous supply of oxygen and nutrients to function efficiently.
- For this reason, cardiac muscle has an extensive network of blood vessels to bring oxygen to the contracting cells and to remove waste products.
- The right and left coronary arteries, branches of the ascending aorta, supply blood to the walls of the myocardium.
- After blood passes through the capillaries in the myocardium, it enters a system of cardiac (coronary) veins.
- Most of the cardiac veins drain into the coronary sinus, which opens into the right atrium.

Physiology of the Heart

- The conduction system includes several components.
- The first part of the conduction system is the sinoatrial node .
- Without any neural stimulation, the sinoatrial node rhythmically initiates impulses 72 times per minute.
- Because it establishes the basic rhythm of the heartbeat, it is called the pacemaker of the heart.
- Other parts of the conduction system include the atrioventricular node, atrioventricular bundle, bundle branches, and conduction myofibers.
- All of these components coordinate the contraction and relaxation of the heart chambers.

Cardiac Cycle

- The cardiac cycle refers to the alternating contraction and relaxation of the myocardium in the walls of the heart chambers, coordinated by the conduction system, during one heartbeat.
- Systole is the contraction phase of the cardiac cycle, and diastole is the relaxation phase. At a normal heart rate, one cardiac cycle lasts for 0.8 second.

Heart Sounds

- The sounds associated with the heartbeat are due to vibrations in the tissues and blood caused by closure of the valves.
- Abnormal heart sounds are called murmurs.

Heart Rate

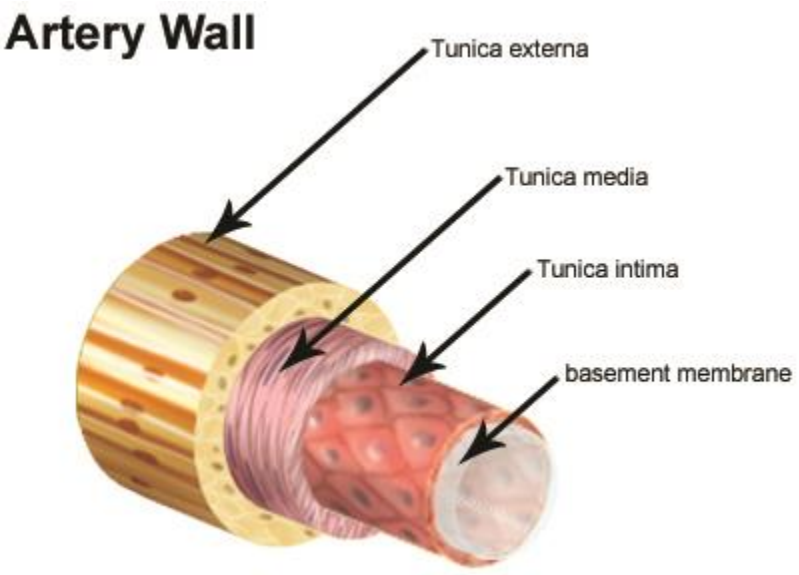
- The sinoatrial node, acting alone, produces a constant rhythmic heart rate.
- Regulating factors are reliant on the atrioventricular node to increase or decrease the heart rate to adjust cardiac output to meet the changing needs of the body.
- Most changes in the heart rate are mediated through the cardiac center in the medulla oblongata of the brain.
- The center has both sympathetic and parasympathetic components that adjust the heart rate to meet the changing needs of the body.
- Peripheral factors such as emotions, ion concentrations, and body temperature may affect heart rate. These are usually mediated through the cardiac center.

b)Blood vessels and classification:

- Blood vessels are the channels or conduits through which blood is distributed to body tissues.
- The vessels make up two closed systems of tubes that begin and end at the heart.
- One system, the pulmonary vessels, transports blood from the right ventricle to the lungs and back to the left atrium.
- The other system, the systemic vessels, carries blood from the left ventricle to the tissues in all parts of the body and then returns the blood to the right atrium
- Based on their structure and function, blood vessels are classified as either arteries, capillaries, or veins.

Arteries:

- Arteries carry blood away from the heart.
- Pulmonary arteries transport blood that has a low oxygen content from the right ventricle to the lungs.
- Systemic arteries transport oxygenated blood from the left ventricle to the body tissues.
- Blood is pumped from the ventricles into large elastic arteries that branch repeatedly into smaller and smaller arteries until the branching results in microscopic arteries called arterioles.
- The arterioles play a key role in regulating blood flow into the tissue capillaries. About 10 percent of the total blood volume is in the systemic arterial system at any given time.

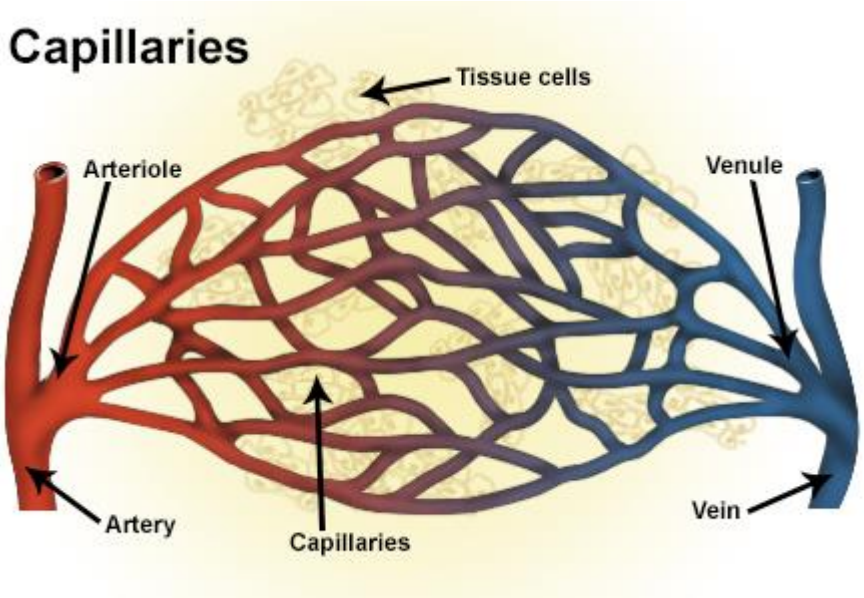


- The wall of an artery consists of three layers.
- The innermost layer, the tunica intima (also called tunica interna), is simple squamous epithelium surrounded by a connective tissue basement membrane with elastic fibers.
- The middle layer, the tunica media, is primarily smooth muscle and is usually the thickest layer.
- It not only provides support for the vessel but also changes vessel diameter to regulate blood flow and blood pressure.
- The outermost layer, which attaches the vessel to the surrounding tissue, is the tunica externa or tunica adventitia.

- This layer is connective tissue with varying amounts of elastic and collagenous fibers.
- The connective tissue in this layer is quite dense where it is adjacent to the tunic media, but it changes to loose connective tissue near the periphery of the vessel.

Capillaries:

- Capillaries, the smallest and most numerous of the blood vessels, form the connection between the vessels that carry blood away from the heart (arteries) and the vessels that return blood to the heart (veins).
- The primary function of capillaries is the exchange of materials between the blood and tissue cells.

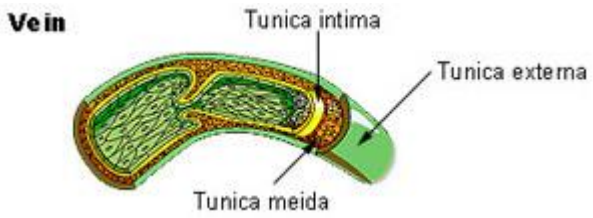


- Capillary distribution varies with the metabolic activity of body tissues.
- Tissues such as skeletal muscle, liver, and kidney have extensive capillary networks because they are metabolically active and require an abundant supply of oxygen and nutrients.
- Other tissues, such as connective tissue, have a less abundant supply of capillaries.
- The epidermis of the skin and the lens and cornea of the eye completely lack a capillary network.
- About 5 percent of the total blood volume is in the systemic capillaries at any given time.
- Another 10 percent is in the lungs.

- Smooth muscle cells in the arterioles where they branch to form capillaries regulate blood flow from the arterioles into the capillaries.

Veins:

- Veins carry blood toward the heart.
- After blood passes through the capillaries, it enters the smallest veins, called venules.
- From the venules, it flows into progressively larger and larger veins until it reaches the heart.
- In the pulmonary circuit, the pulmonary veins transport blood from the lungs to the left atrium of the heart.
- This blood has a high oxygen content because it has just been oxygenated in the lungs.
- Systemic veins transport blood from the body tissue to the right atrium of the heart.
- This blood has a reduced oxygen content because the oxygen has been used for metabolic activities in the tissue cells.



- The walls of veins have the same three layers as the arteries.
- Although all the layers are present, there is less smooth muscle and connective tissue.
- This makes the walls of veins thinner than those of arteries, which is related to the fact that blood in the veins has less pressure than in the arteries.
- Because the walls of the veins are thinner and less rigid than arteries, veins can hold more blood.
- Almost 70 percent of the total blood volume is in the veins at any given time.
- Medium and large veins have venous valves, similar to the semilunar valves associated with the heart, that help keep the blood flowing toward the heart.
- Venous valves are especially important in the arms and legs, where they prevent the backflow of blood in response to the pull of gravity.

2.a)What is cardiac cycle? **(5+6+4)**

b)Draw a labeled diagram of heart.

c)Write the function of blood.

a)Cardiac cycle:

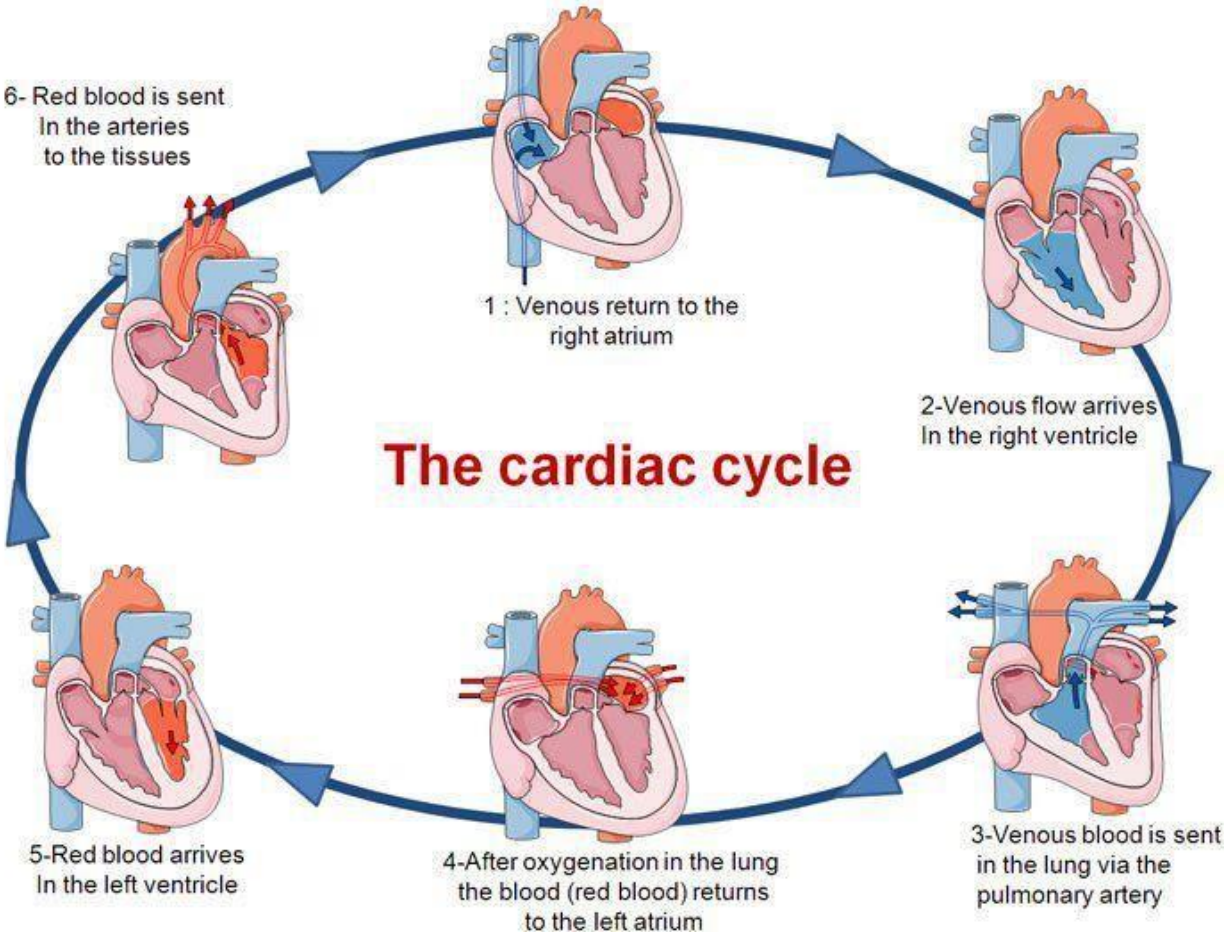
- The **cardiac cycle** is the performance of the human heart from the ending of one heartbeat to the beginning of the next.
- It consists of two periods: one during which the heart muscle relaxes and refills with blood, called diastole,
- following a period of robust contraction and pumping of blood, called systole.
- After emptying, the heart immediately relaxes and expands to receive another influx of blood *returning from* the lungs and other systems of the body, before again contracting to *pump blood to* the lungs and those systems.
- A normally performing heart must be fully expanded before it can efficiently pump again.
- Assuming a healthy heart and a typical rate of 70 to 75 beats per minute, each cardiac cycle, or heartbeat, takes about 0.8 seconds to complete the cycle.
- There are two atrial and two ventricle chambers of the heart; they are paired as the left heart and the right heart—that is, the left atrium with the left ventricle, the right atrium

with the right ventricle—and they work in concert to repeat the cardiac cycle continuously.

- At the start of the cycle, during ventricular diastole–early, the heart relaxes and expands while receiving blood into both ventricles through both atria; then, near the end of ventricular diastole–late, the two atria begin to contract (atrial systole), and each atrium pumps blood into the ventricle.
- During ventricular systole the ventricles are contracting and vigorously pulsing (or ejecting) two separated blood supplies from the heart—one to the lungs and one to all other body organs and systems—while the two atria are relaxed (atrial diastole). This precise coordination ensures that blood is efficiently collected and circulated throughout the body.
- The mitral and tricuspid valves, also known as the atrioventricular, or AV valves, open during ventricular diastole to permit filling.
- Late in the filling period the atria begin to contract (atrial systole) forcing a final crop of blood into the ventricles under pressure.
- Then, prompted by electrical signals from the sinoatrial node, the ventricles start contracting (ventricular systole), and as back-pressure against them increases the AV valves are forced to close, which stops the blood volumes in the ventricles from flowing in or out; this is known as the *isovolumic contraction* stage.
- Due to the contractions of the systole, pressures in the ventricles rise quickly, exceeding the pressures in the trunks of the aorta and the pulmonary arteries and causing the requisite valves (the aortic and pulmonary valves) to open—which results in separated blood volumes being ejected from the two ventricles.
- This is the ejection stage of the cardiac cycle; it is depicted as the *ventricular systole–first phase* followed by the *ventricular systole–second phase*.
- After ventricular pressures fall below their peak(s) and below those in the trunks of the aorta and pulmonary arteries, the aortic and pulmonary valves close again.

- Now follows the *isovolumic relaxation*, during which pressure within the ventricles begin to fall significantly, and thereafter the atria begin refilling as blood returns to flow into the right atrium (from the vena cavae) and into the left atrium (from the pulmonary veins).

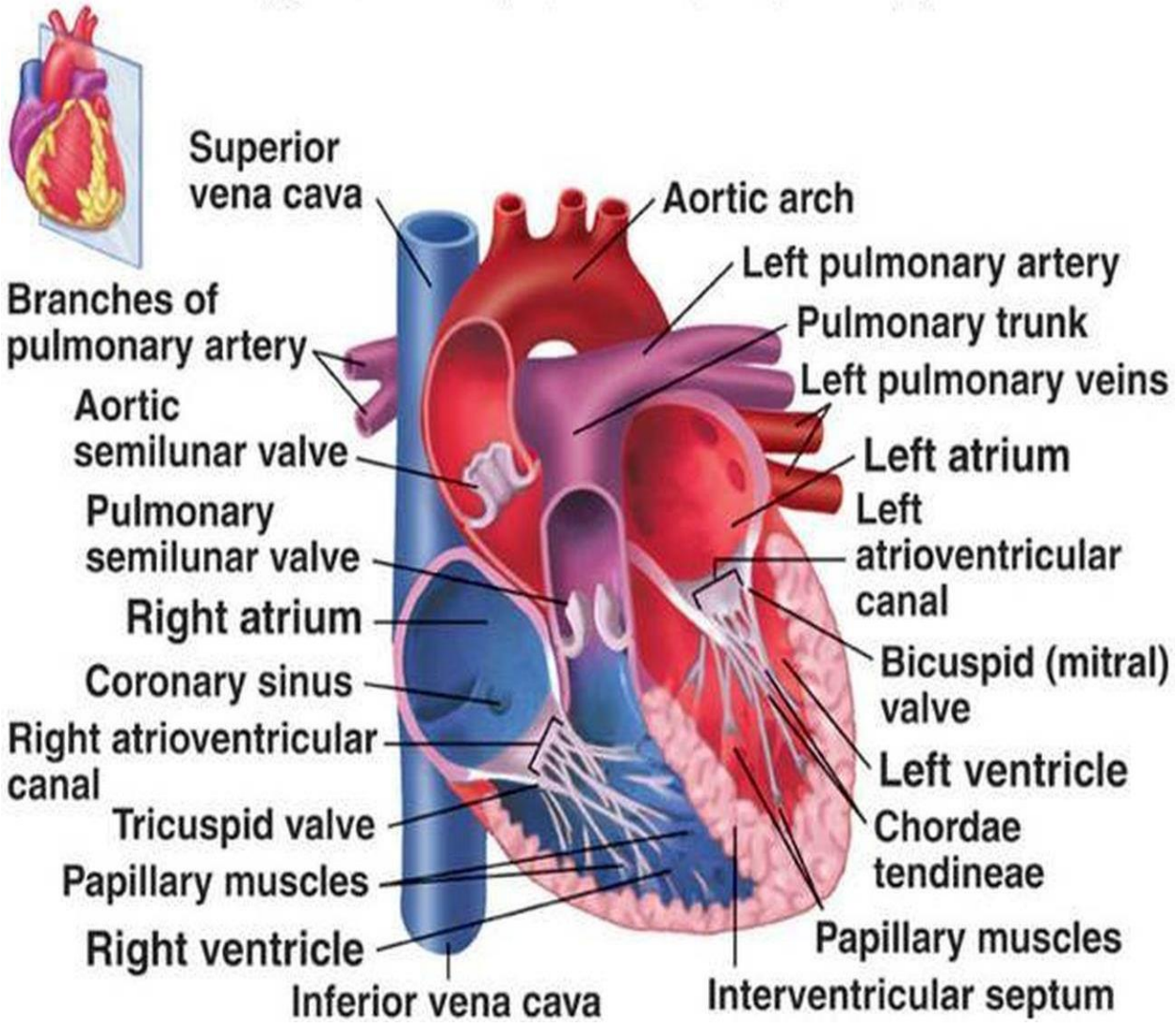
- As the ventricles begin to relax, the mitral and tricuspid valves open again, and the completed cycle returns to ventricular diastole and a new "Start" of the cardiac cycle.
- Throughout the cardiac cycle, blood pressure increases and decreases.
- The movements of cardiac muscle are coordinated by a series of electrical impulses produced by specialised pacemaker cells found within the sinoatrial node and the atrioventricular node.
- Cardiac muscle is composed of myocytes which initiate their internal contractions without applying to external nerves—with the exception of changes in the heart rate due to metabolic demand.



b)Diagram of heart:

- The heart is a roughly cone-shaped hollow muscular organ.
- It is about 10cm long and weighs about 225g in women and 310g in men.
- The heart lies obliquely in the thoracic cavity in the mediastinum, slightly more to the left of the chest.

- The apex is about 9cm to the left of the midline at the level of the 5th intercostals space, i.e. a little below the nipple and slightly nearer the midline.
- The base extends to the level of the 2nd rib.



C)Function of blood:

Blood has three main functions: transport, protection and regulation.

Transport

Blood transports the following substances:

- Gases, namely oxygen (O_2) and carbon dioxide (CO_2), between the lungs and rest of the body
- Nutrients from the digestive tract and storage sites to the rest of the body
- Waste products to be detoxified or removed by the liver and kidneys
- Hormones from the glands in which they are produced to their target cells
- Heat to the skin so as to help regulate body temperature

Protection

Blood has several roles in inflammation:

- Leukocytes, or white blood cells, destroy invading microorganisms and cancer cells
- Antibodies and other proteins destroy pathogenic substances
- Platelet factors initiate blood clotting and help minimise blood loss

Regulation

Blood helps regulate:

- pH by interacting with acids and bases
- Water balance by transferring water to and from tissues

Blood has a number of functions that are central to survival, including:

- supplying oxygen to cells and tissues
- providing essential nutrients to cells, such as amino acids, fatty acids, and glucose
- removing waste materials, such as carbon dioxide, urea, and lactic acid
- protecting the body from infection and foreign bodies through the white blood cells
- transporting hormones from one part of the body to another, transmitting messages, and completing important processes

- regulating acidity (pH) levels and body temperature
- engorging parts of the body when needed, for example, a penile erection as a response to sexual arousal

Another important function of the blood is its protective action against disease. White blood cells defend the body against infections, foreign materials, and abnormal cells.

The platelets in blood enable the clotting, or coagulation, of blood. When bleeding occurs, the platelets group together to create a clot. The clot becomes a scab and stops the bleeding, as well as helping to protect the wound from infection.