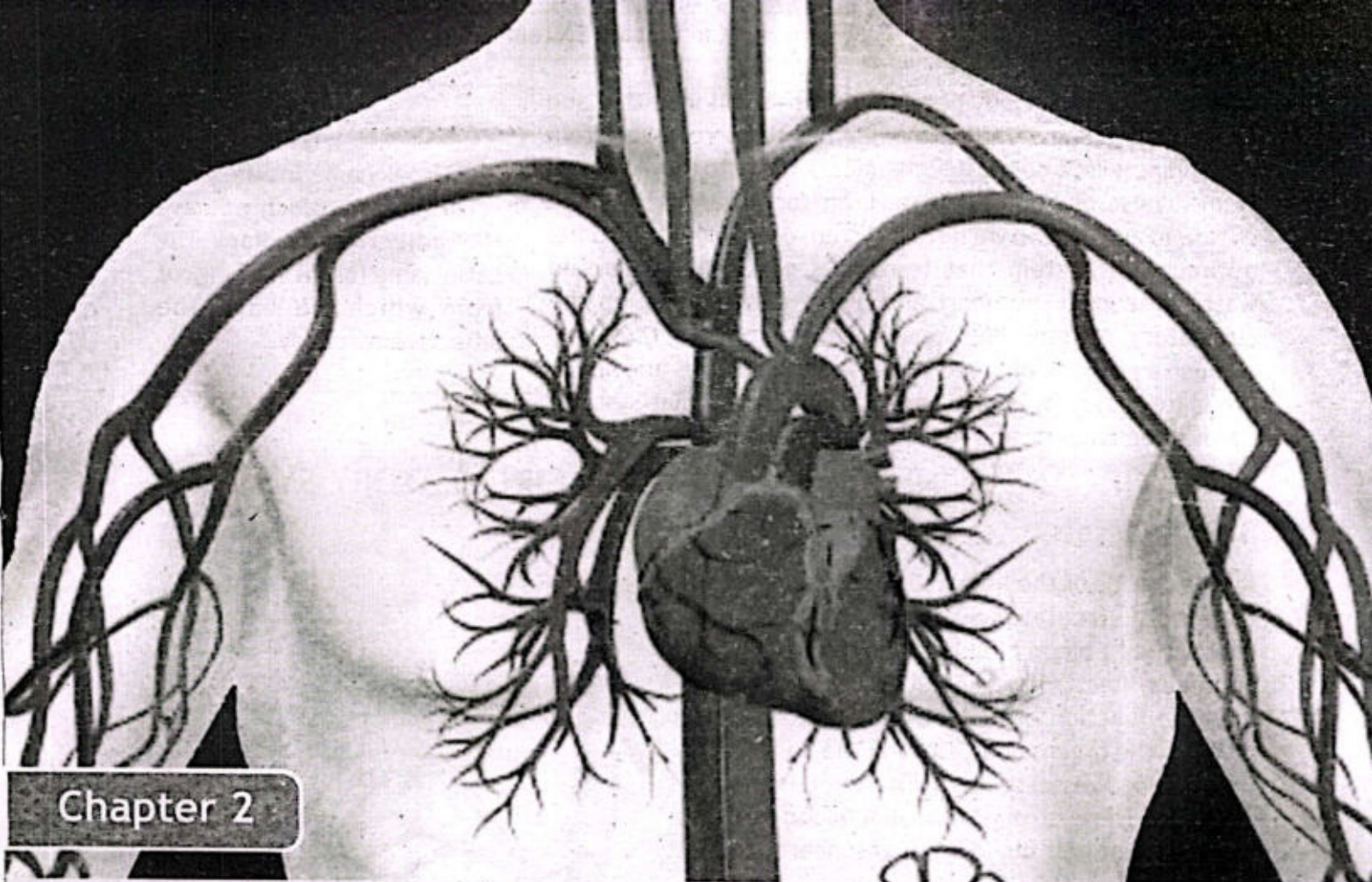




Chapter 2

CIRCULATORY SYSTEM

SLOs: After completing this lesson, the student will be able to:

1. [B-10-R-10] Identify different types of organs connected to the blood circulatory system and their roles.
2. [B-10-R-11] Identify the different components that make up the blood.
3. [B-10-R-12] Name the cell types found in blood and their roles.
4. [B-10-1-07] Describe the process of blood clotting.
5. [B-10-R-13] Explain the structure of heart with a diagram.
6. [B-10-R-08] Describe how the blood is circulated inside the human body.
7. [B-10-R-09] Explain how blood is used to transport materials throughout the human body.
8. [B-10-R-14] Explain common heart diseases. (Coronary heart disease, Myocardial infarction, Angina)
9. [B-10-R-15] Explain the harmful effects of smoking related to heart diseases.

All the cells of our body need food from small intestine and oxygen from lungs. Carbon dioxide has to be removed from the lungs. Likewise waste chemicals have to be removed from kidneys. Our bodies are too large for materials to simply diffuse in and out. So we have a system of internal transport, a circulatory system that transports gases, nutrients and waste products. The heart and blood vessels make up the circulatory system. The heart pumps blood to the body through a network of blood vessels called arteries and veins. Circulatory system is also known as cardiovascular system. Cardio means heart, and vascular refers to blood vessels.

Do you know ?

The Greek name for the heart is *cardia* from which we have the adjective **cardiac**. The Latin name for the heart is *cor* from which we have the adjective **coronary**.

2.1 ORGANS CONNECTED TO BLOOD CIRCULATORY SYSTEM

Blood Vessels

All the organs of the human body are connected to blood circulatory system. The organs connected to blood circulatory system are head and neck, heart, liver, intestine, kidney, arms, leg. The function of blood vessels is to deliver blood to the organs and tissues in the body. Each type of blood vessel serves a different function:

Arteries: These strong, muscular blood vessels carry oxygen-rich blood from the heart to the body.

Arterioles: Arteries branch into smaller vessels called arterioles. Both arteries and arterioles are very flexible. They get bigger or smaller to help maintain your body's blood pressure.

Capillaries: These tiny blood vessels have thin walls. Oxygen and nutrients from the blood can move through the walls and get into organs and tissues.

The capillaries also take waste products away from your tissues. Capillaries are where oxygen and nutrients are exchanged for carbon dioxide and waste.

Venules: Veins begin as tiny vessels called venules and get gradually larger as they near your heart. Venules receive blood from capillaries.

Veins: Veins carry large volumes of deoxygenated blood back to the heart. Thin, less elastic walls help them handle high volumes and low pressure. Most veins have valves that open and close. The valves control blood flow and keep the blood flowing in one direction.

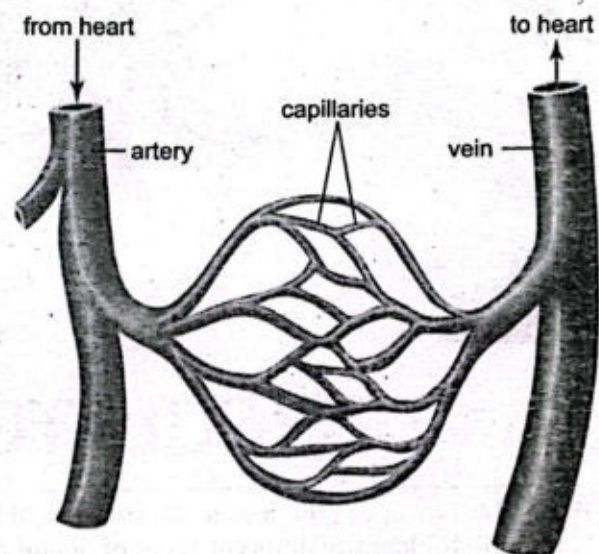


Fig. 2.1: Blood vessels

Contributions of William Harvey (1578-1657)

William Harvey discovered pumping action of the heart. He described pulmonary and systemic circulation in more elaborated way. He recognized valves in veins and their role to maintain one way flow of blood. He also described that blood flows in a closed circuit.

Contributions of Ibn al Nafees (1213-1288)

Ibn al Nafees was a polymath who made many contributions in medicine and surgery. He was the first scientist who described circulation. He stated that;

- There is no direct movement of blood between right and left side of the heart.
- Blood moves from right side of the heart to lungs and then returns to the left side of the heart.
- The small connections (now known as capillaries) are present between arteries and veins in lungs.
- Pulse results from pumping action of heart.

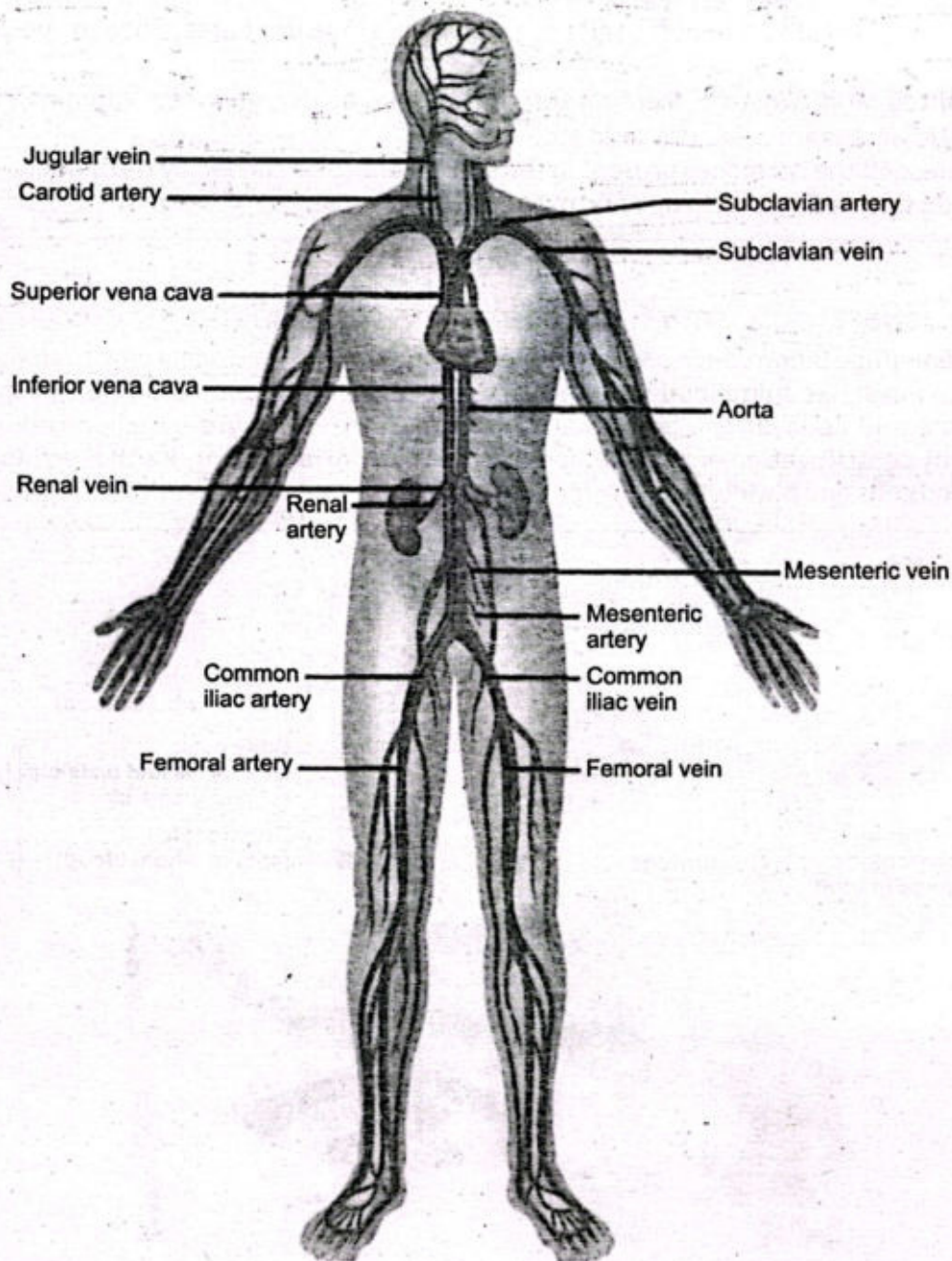


Fig. 2.2: Major arteries and veins

2.2 COMPONENTS OF BLOOD

Blood is a type of special connective tissue with cells suspended in a fluid medium. The blood circulates in the blood vessels. Almost all the substances to be transported are present either dissolved or suspended in the blood. Blood consists of plasma and blood cells.

Plasma

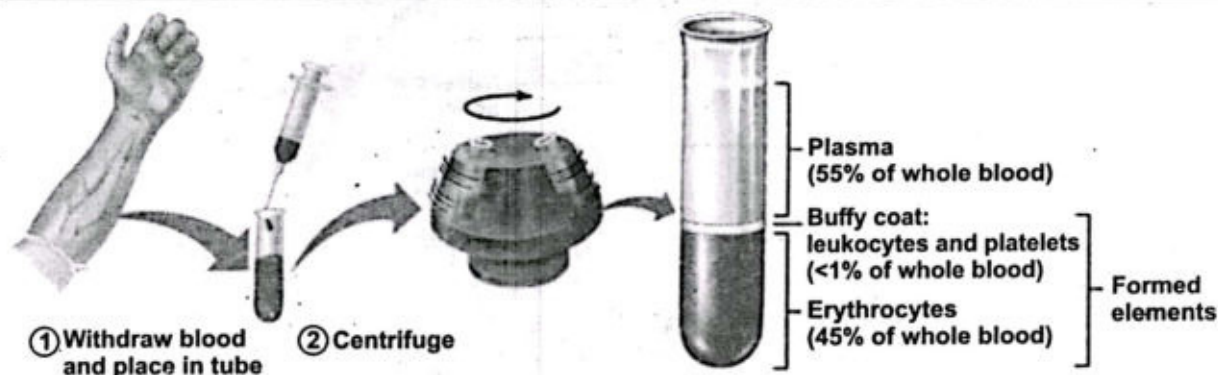
The liquid part of the blood is called plasma. It constitutes about 55% by volume of blood in a normal person. Plasma contains 90% water and dissolved substances 10%.

1. **Plasma Proteins:** 7-9% of the plasma is made of different types of proteins e.g., fibrinogen takes part in blood clotting, immunoglobulins (antibodies) defend against diseases and albumins maintain osmotic pressure.
2. **Mineral Ions:** Dissolved mineral salts e.g., chlorides, bicarbonates, sodium, potassium and calcium.
3. **Metabolites and Wastes:** Metabolites are amino acids, glucose, vitamins, lipids and metabolic wastes are urea, uric acid etc.
4. **Hormones:** All the hormones present in the plasma are to be carried by the blood.
5. **Dissolved Gases:** Carbon dioxide and oxygen in the plasma.

Do you know?

How to separate plasma from the other components of blood?

You can centrifuge blood which separates the components of blood according to their density. Centrifuge machines spin blood samples very fast to separate out. The yellow, top layer is plasma, the middle layer is a buffy coat (Buffy coats are leukocyte-enriched residual units obtained by centrifugation of whole blood) and the bottom layer contains the red blood cells, white blood cells and platelets.



Centrifuge Machine

2.3 CELL TYPES FOUND IN BLOOD

Blood cells form about 45% by volume of the blood. These include red blood cells, white blood cells and platelets.

a. Red Blood Cells

These are called **erythrocytes**. A single R.B.C is a circular flattened, biconcave disc and has no nucleus. RBCs have iron-containing pigment haemoglobin in its cytoplasm, which gives red colour to the blood. RBCs are formed in bone marrow after birth. Their life span is 120 days. When they are worn-out, they are destroyed in spleen and liver. RBCs carry oxygen and also transport a small amount of carbon dioxide.

b. White Blood Cells

White blood cells are called **leukocytes**. Their life span is 3-4 days. Each white blood cell is irregular in shape and contains a nucleus. WBC's can be divided into two main types:

1. Granular leukocytes
2. Agranular leukocytes

Granular Leukocytes

Their nucleus is variable in shape. Cytoplasm contains fine granules. These cells originate in bone marrow. Granular leukocytes are of three types, neutrophils, eosinophils and basophils.

Neutrophils: Neutrophils engulf pathogens during phagocytosis.

Eosinophils: Eosinophils are involved in the control of allergic reactions.

Basophils: Basophils release histamine in injured tissue and in allergic response.

Agranular Leukocytes

The cytoplasm of agranular leukocytes is clear. These are of two types i.e., monocytes and lymphocytes.

Monocytes: These are phagocytic and ingest bacteria and dead cells at the damaged tissue region.

Lymphocytes: There are two types of lymphocytes. **B Lymphocytes** protect us by producing antibodies. **T lymphocytes** directly destroy any cell that can be harmful e.g., virus infected cells and cancerous cells.

Do you know?

White blood cells are transparent. To distinguish them from red blood cells they are called white blood cells.

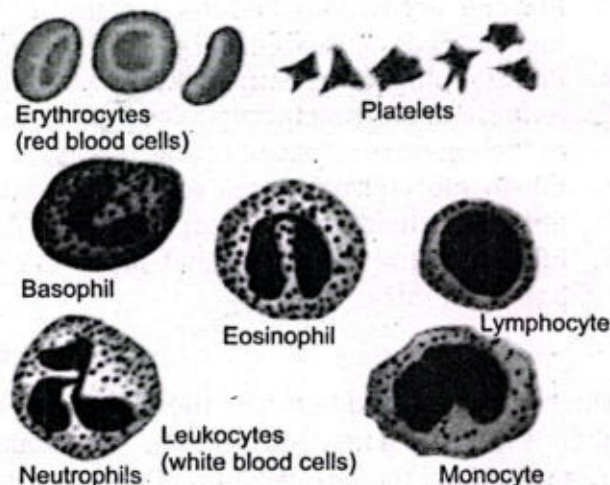


Fig. 2.3: Blood cells

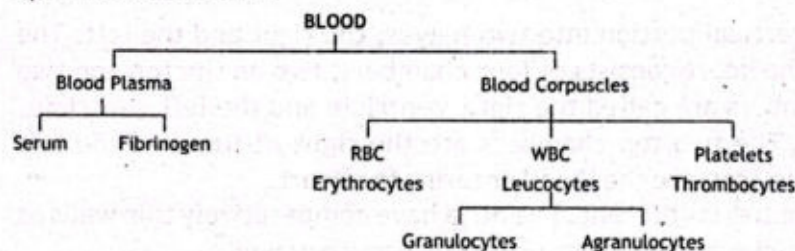


Fig. 2.4: Components of blood

Do you know?

Serum is the clear liquid part of the blood that remains after blood cells and clotting proteins have been removed.

c. Platelets

Platelets are also known as **thrombocytes**. Bone marrow cells called **megakaryocytes** form fragments called **platelets**. Platelets play an important role in blood clotting.

2.4 BLOOD CLOTTING

Blood clotting, or coagulation, is an important process that prevents excessive bleeding when a blood vessel is injured. Platelets and plasma proteins (Thrombin, fibrinogen etc.) work together to stop the bleeding by forming a clot over the injury. While its primary function is to maintain homeostasis, blood clotting also plays a role in immunity.

Steps of blood clotting

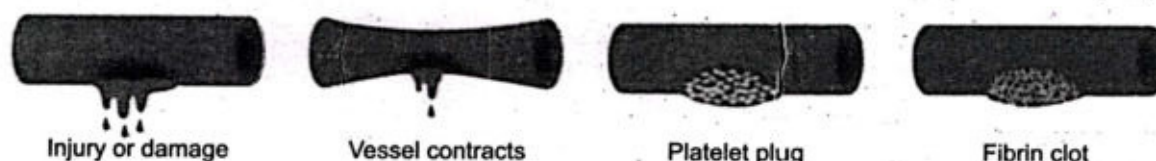


Fig. 2.5: Steps of Blood Clotting

1. **Injury:** Blood vessel is injured or ruptured. Vessel damage exposes collagen and activates platelets.
2. **Constriction:** Blood vessel around wound constricts to reduce blood flow to the damaged area.
3. **Platelet activation:** Platelets release chemical signals which attract more platelets and immune cells. Activated platelets stick to injury site.
4. **Platelet plug formation:** Sticky platelets clump together to form platelet plug.
5. **Release of clotting factors:** The injured tissue cells and the platelets disintegrate at the site of the wound to release clotting factors.
6. **Fibrin clot formation:** A series of reactions involving clotting factors (e.g., thrombin, fibrinogen) leads to fibrin clot formation.
7. **Fibrin clot:** A solid mass that provides a physical barrier to prevent blood loss and stop pathogen entry.

2.5 HEART

The heart is located between the lungs behind the sternum and above the diaphragm. It's only about the size of a fist, and it weighs 7 to 15 ounces. It's a hollow, muscular organ. It is surrounded by a sac called the **pericardium**. There is a fluid between the heart and the pericardium called **pericardial fluid**. It is lubricating fluid, which reduces friction between the pericardium and heart. The thick middle layer of the heart is called **myocardium**. The smooth inner surface of the heart chambers is **endocardium**.

2.5.1 The Heart Chambers

Internally, the heart is divided by a vertical portion into two halves, the right and the left. The vertical partition is called **septum**. The heart consists of four chambers, two on the top and two on the bottom. The two bottom chambers are called the **right ventricle** and the **left ventricle**. They pump blood out of the heart. The two top chambers are the **right atrium** and the **left atrium**, the plural of which is **atria**. They receive the blood entering the heart.

The thickness of the walls of each chamber is different. The atria have comparatively thin walls as they have to force blood into the ventricles and this does not require much power.

On the other hand, the ventricles have to force blood out of the heart hence they have relatively thick walls, especially the left ventricle which has to pump blood around the whole body. The right ventricle has thinner than the left ventricle in a ratio of 1:3; it pumps blood to the lungs, which are at a short distance from the heart. The human heart is myogenic (A heart that does not require neural input to beat is called myogenic heart.)

2.5.2 The Heart Valves

The heart also has four valves, which separate the top chambers from the bottom chambers and also move blood.

Atrioventricular valves separate the atria from the ventricles. Each valve is composed of cusps or flaps. The valve between the right atrium and right ventricle has three cusps and is called **tricuspid valve**.

The valve between left atrium and left ventricle has two cusps and is called **bicuspid or mitral valve**. **Tricuspid valve** separates the right side, and the **bicuspid valve** separates the left side. Two additional valves separate the ventricles from the large blood vessels that carry blood leaving the heart. The **pulmonic semilunar valve** is between the right ventricle and pulmonary artery. It carries blood to the lungs. The **aortic semilunar valve** is between the left ventricle and the aorta. It carries blood to the body.

The atria receive blood and the ventricles distribute it. Blood from the head, neck and arms is returned to the right atrium by superior vena cava. Blood from lower parts of the body is brought back by the inferior vena cava to the right atrium. Thus, the right atrium receives deoxygenated blood from the superior and inferior vena cava. When the right atrium contracts, the blood flows into the right ventricle through the tricuspid valve.

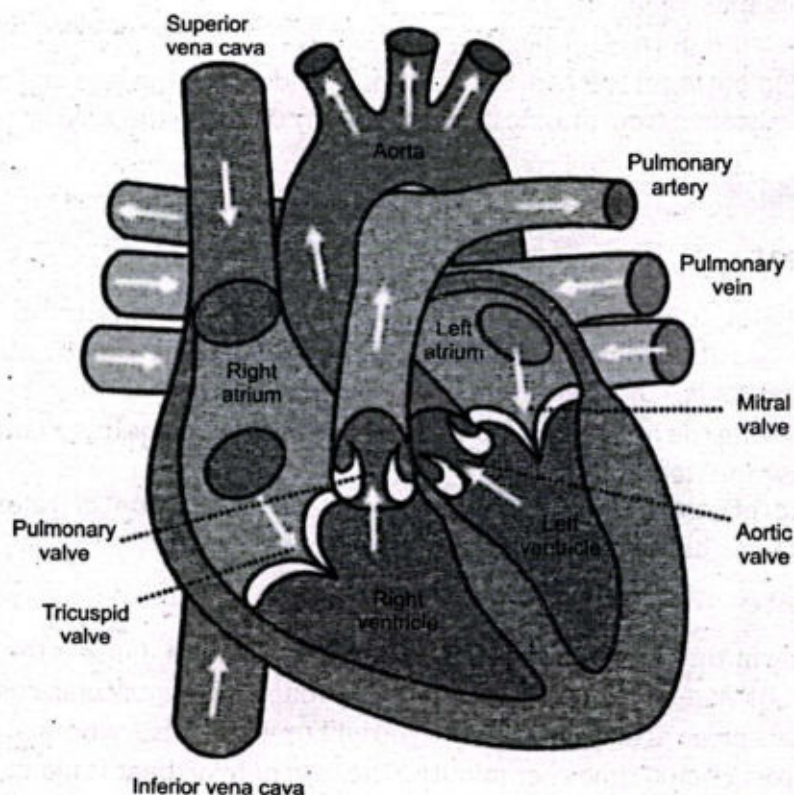


Fig. 2.6: Human heart

When the right ventricle contracts the blood pressure closes tricuspid valve. This prevents back flow of blood into the atrium. The blood leaves the right ventricle by pulmonary trunk. The pulmonary trunk divides into two pulmonary arteries one to each lung. Return of blood into the ventricle is prevented by semilunar valves in the pulmonary trunk. Oxygenated blood from the lungs is brought back to the heart by way of the pulmonary veins, which open into the left atrium. When the left atrium contracts the blood enters the left ventricle through bicuspid valve.

When the left ventricle contracts, blood leaves by a large artery, the aorta. From the aorta blood is distributed to all parts of the body except lungs. Aorta also has semilunar valves to prevent back flow into the left ventricle.

Right ventricle pumps deoxygenated blood to lungs at low pressure. This is because blood has to travel short distance from heart to lungs. Also, lungs are filled with air which creates very little resistance. The pulmonary arteries are not as muscular as systemic arteries. The low pressure in pulmonary circulation allows easy exchange of gases in alveoli.

Left ventricle pumps blood to the body at high pressure because it has

to drive the blood out from the heart and all the way down to the legs and arms. It is required to overcome the resistance from muscles and other body tissue on the way.

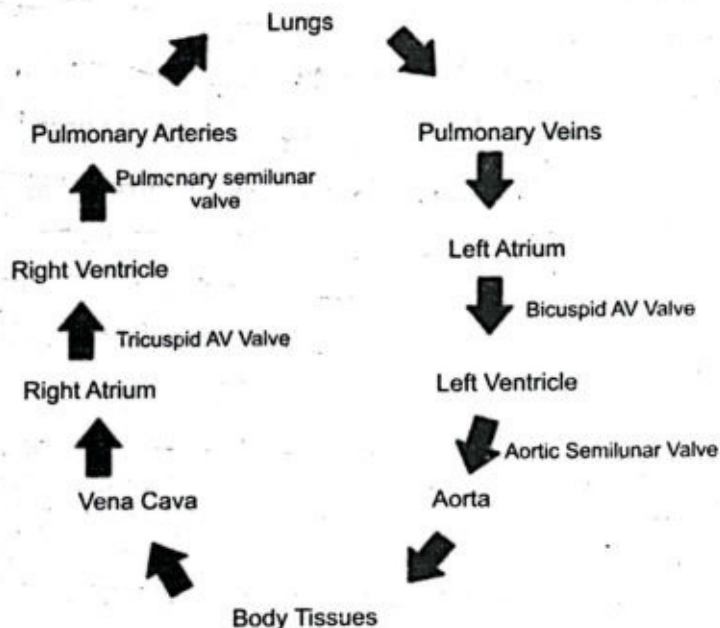


Fig. 2.7: Passage of blood through heart

For your information

Heartbeat

The alternating contraction and relaxation of the atria and ventricles is called cardiac cycle. The two atria contract simultaneously emptying blood into ventricles. A fraction of a second later, the two ventricles contract simultaneously, forcing blood into arteries leaving the heart. Both the ventricles then relax for less than a second before the cycle is repeated.

The period of contraction is called systole and the period of relaxation is called diastole. A heartbeat includes one systole and one diastole.

Pulse Rate

The beating of the heart is also felt in the arteries as pulse. Pulse is the vibration felt in arterial walls due to expansion of the aorta following ventricular contraction. If you place fingers on an artery on the wrist you will feel the pulse. A normal adult pulse rate can vary from 60-100 times per minute. The rate of heartbeat is indicated by the pulse rate.

Arterial system

We will see here major arteries that supply blood the organs and veins that bring blood back to the heart. The **systemic circulation** includes all of the other arteries and veins. The largest artery in the systemic circuit is the **aorta**, which branches into arteries leading to the organs. The following major arteries are:

1. **Coronary arteries:** Supply blood to the heart itself.
2. **Carotid arteries:** Supply blood to the head and neck.
3. **Subclavian arteries:** Supply blood to shoulders and arms.
4. **Dorsal aorta:** Aorta curls backward and continues downwards as the dorsal aorta.

From the dorsal aorta, the following arteries are given off:

- (a) **Hepatic artery:** Supplies blood to the liver.
- (b) **Mesenteric arteries:** Supply blood to the intestine.
- (c) **Renal arteries:** Supply blood one to each kidney.
- (d) **Common iliac arteries:** Supply blood one to each leg.

This artery divides into **femoral artery**.

Do you know?

- There are 160, kilometers of blood vessels in your body.
- Your body makes one billion red blood cells everyday.

Venous system

Blood is returned to the heart by the main veins as follows:

1. **Jugular veins:** Bring blood from head and neck.
2. **Subclavian veins:** Bring blood from the shoulders and arms.
3. **Superior vena cava:** Jugular and subclavian veins unite to form the superior vena cava which opens into the right atrium of the heart.
4. **Common iliac veins and femoral veins:** Brings blood from the lower limbs.
5. **Renal veins:** Bring blood from the kidneys.
6. **Hepatic veins:** Bring blood from liver and digestive system.
7. **Inferior vena cava:** Iliac, renal and hepatic veins join to form inferior vena cava. It opens into the right atrium of the heart.
8. **Hepatic Portal Vein:** The veins from the digestive system do not open directly into the inferior vena cava. They unite to form the **hepatic portal vein**. It enters the liver and breaks up into many capillaries. The capillaries join to form hepatic vein. A **portal vein** is so called because it carries blood from one capillary network to another.

2.6 CIRCULATION OF BLOOD

The circulatory system provides blood to all the body's tissues so they can function. The circulatory system has three circuits. Blood circulates through heart and through these circuits in a continuous pattern:

- a. **The pulmonary circuit:** This circuit carries deoxygenated blood (blood without oxygen) from the heart to the lungs. The pulmonary veins return oxygenated blood to the heart.
- b. **The systemic circuit:** In this circuit oxygenated blood (blood with oxygen), travels from the heart to the rest of the body. In the veins, the blood picks up carbon dioxide and other waste products as the body uses up the oxygen. The veins bring the blood back to the heart.
- c. **The coronary circuit:** Coronary refers to the arteries of the heart. This circuit provides the heart muscle with oxygenated blood. The coronary circuit then returns deoxygenated blood to the heart's right upper chamber (atrium) to send to the lungs for oxygen.

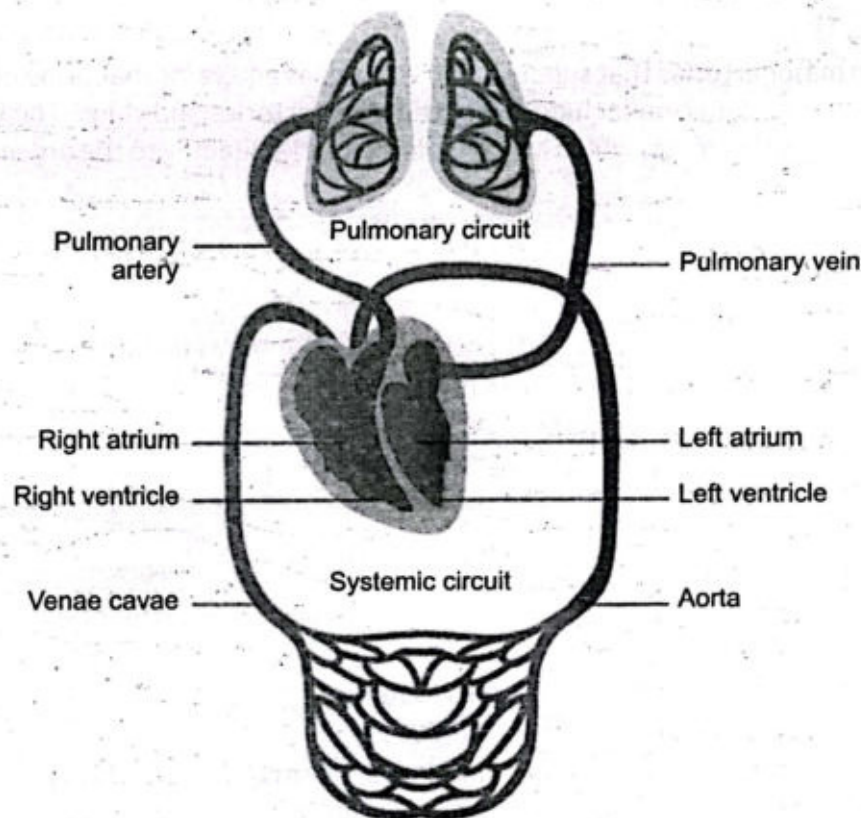


Fig. 2.9: Circulation of blood in human body

2.7 TRANSPORTATION OF MATERIAL THROUGH BLOOD

One of the main functions of blood is transport. The materials that are transported through blood are digested food, oxygen, carbon dioxide, excretory waste, hormones and heat.

The functions of the blood are:

1. **Transport of digested food:** The digested substances transported from the alimentary canal to tissues are simple sugars like glucose, amino acids, vitamins, mineral salts, etc. Amino acids and simple sugars are absorbed into the blood through the blood capillaries. Fatty acids are absorbed by the lacteals.
2. **Transport of oxygen:** Oxygen is transported by red blood cells. The red blood cells contain a pigment called haemoglobin. Each molecule of which binds four oxygen molecules forming oxyhaemoglobin. The oxygen molecules are carried to the cells in the body tissue. The oxyhaemoglobin release the oxygen to the tissues.
3. **Transport of carbon dioxide:** There are three means by which carbon dioxide is transported in the bloodstream from tissues and back to the lungs: (a) in the form of bicarbonate ions (b) in the form of carboxyhaemoglobin (c) A small amount of carbon dioxide is transported as dissolved in plasma.
4. **Transport of excretory materials:** Wastes are excreted from cells. They get dissolved in the blood. The blood carries them to kidneys through blood capillaries. The waste materials get filtered out of the blood while useful substances and excess water are reabsorbed into the blood.
5. **Transport of hormones:** Hormones are transported through the blood from the place of origin to the target cells. Each hormone acts upon only those cells which have specific receptors. The cells which are acted upon by hormones are called target cells.

6. **Distribution of heat:** The blood plays a role in temperature regulation. It distributes heat throughout the body. By changing the blood flow to the skin, the body can control heat exchange at its surface with its surroundings.

2.8 COMMON HEART DISEASES

The disorders of the heart and blood vessels are called cardiovascular disorders. Cardiovascular disorders are the leading cause of untimely death in man.

2.8.1 Coronary Heart Diseases

Arteriosclerosis is hardening of the arteries. Atherosclerosis is the deposition of materials in the arteries. The deposits of cholesterol are called **plaques** which increase in size and begin to block arteries. Plaques can cause a clot to form on the irregular arterial wall. As long as the clot remains stationary, it is called a **thrombus**. If the clots breakaway, it may block artery at another location. The dislodged clot moving along with the blood is called an **embolus**. Hardened arteries lose their elasticity and may get ruptured, a process known as **haemorrhage**.

2.8.2 Myocardial Infarction

If the embolus or large plaque blocks vessel in one of the coronary arteries of the heart, a portion of the heart muscle will not get supply of oxygen. Due to lack of oxygen, this portion of heart muscle dies. Infarction means death due to lack of oxygen. The whole process is called **myocardial infarction**.

Treatment

1. Medical treatment includes the use of an enzyme that dissolves blood clot.
2. **Coronary bypass surgery** is carried out to treat blocked arteries. In this surgery blood vessel from elsewhere in the patient body are grafted to coronary arteries to improve blood supply to heart muscles.
3. **Angioplasty** is the mechanical widening of a narrow or totally blocked coronary artery.

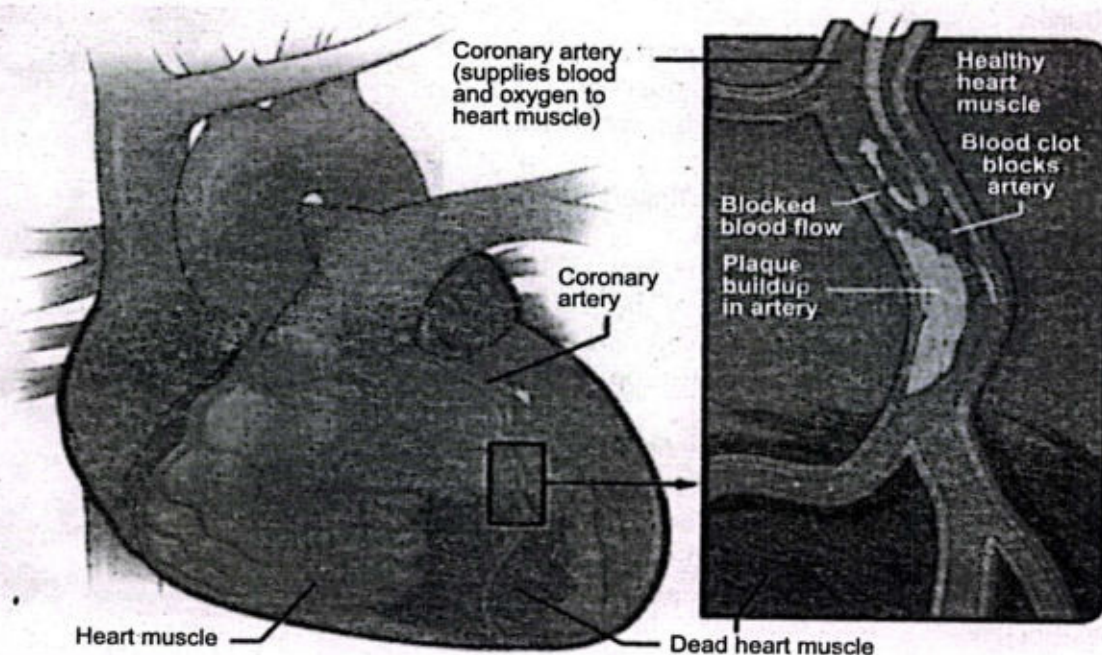


Fig. 2.10: Myocardial Infarction

Prevention

1. Avoid food rich in salt and fats.
2. Maintain healthy body weight.
3. Control blood pressure.
4. Do regular walk and exercise.
5. Avoid smoking
6. Avoid stress.

2.8.3 Angina

Angina is chest pain or discomfort that happens when the heart is not receiving enough oxygen-rich blood. As a result, the heart may beat faster and harder to gain more blood, causing a noticeable pain. Angina is not a disease. It is a symptom and a warning sign of heart disease. The main symptoms of angina are fatigue, nausea or vomiting, shortness of breath and sweating a lot.

2.9 HARMFUL EFFECTS OF SMOKING ON HEART

Smoking damages the heart and blood vessels. Smoking speeds up the clogging and narrowing of coronary arteries. This can reduce the flow of blood to the heart and increases the risk of heart attack. Tobacco smoke contains thousands of chemicals including:

- a. Nicotine is an addictive drug that affects brain and muscle activity and increases blood pressure, making the heart work harder.
- b. Carbon monoxide is a poisonous gas that replaces oxygen in the blood, reducing the supply of oxygen to the heart and other organs. If you smoke, your risk of
 - a. heart attack is more than twice as high as someone who does not smoke
 - b. stroke is more than twice as high as someone who does not smoke.

STEAM ACTIVITY 2.1 (To be demonstrated by teacher) PREPARING HUMAN BLOOD SMEAR

Materials needed:

cotton, alcohol, lancet, glass slides, coverslips, light microscope, Wright's stain
Blood smears are made usually using fresh blood

Procedure:

1. Using lens paper or silk cloth, gently wipe two glass slides to remove any dust or glass fragments. Place the glass slides on an even surface.
2. Thoroughly scrub the skin of one fingertip with a cotton swab and rubbing alcohol.
3. Open a lancet to expose the sharp point (about 3 mm long). Quickly puncture the cleaned fingertip, put the lancet down, and gently squeeze the finger until a small drop of blood forms on the fingertip.
4. Place the drop of blood from the finger into the middle of the glass slide and then wipe the fingertip to clean excess blood. (Bleeding should not be a problem, but if it persists, apply pressure with a cotton ball or paper towel until it stops).



5. Place a small drop of blood on one end of one glass slide. Hold the top and bottom edges of the slide with the thumb of your non-dominant hand.
6. Using your dominant hand, place the edge of the other slide at an approximately 35-45° angle on the first glass slide, in front of the blood drop. Using gentle pressure, gently pull the second slide back into the blood drop and allow the blood to spread to the edge of the slide.
7. To spread the blood, rapidly but gently push the top slide forward through the remainder of the slide. It is important to keep gentle, equal pressure throughout the whole process, and do not lift the top slide before it reaches the edge of the bottom slide. A feathered edge should be present.
8. After preparation, the smear should be labeled and dried (air dryer or waving method). Put a drop of Wright's stain
9. Put a coverslip.
10. Put the covered blood smear on the microscope stage with the cover slip toward the objective lens and focus until blood cells are visible.

Red blood cells are by far the most numerous. White blood cells are slightly larger. There is usually only about one white blood cell for every 1,000 red blood cells.

Wright's stain: Contains eosin Y and methylene blue, which stain different parts of WBCs. Eosin Y stains the cytoplasm pink or orange, while methylene blue stains the nucleus blue. It stains RBCs red

Permanent slide: Observe prepared permanent slide of human blood film under a light microscope and identify the blood cell.

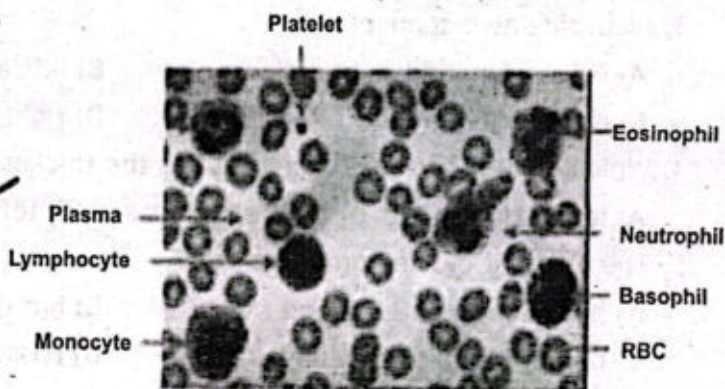
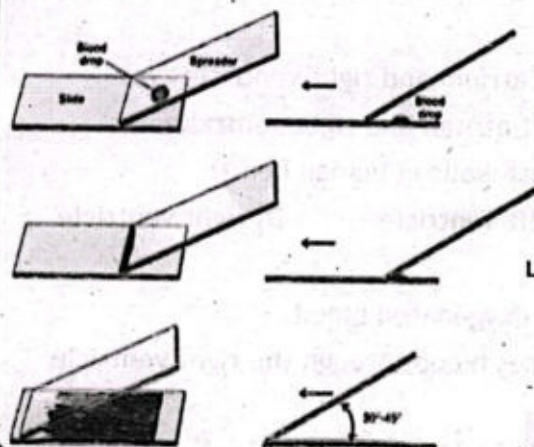


Fig.: Permanent prepared slide of human blood film

SUMMARY

- Human blood consists of liquid plasma in which red blood cells, white blood cells and platelets are suspended.
- Red blood cells transport oxygen and small amount of carbon dioxide.
- White blood cells defend the body against diseases. Lymphocytes and monocytes are agranular white blood cells while neutrophils, eosinophils and basophils are granular white blood cells.
- Platelets patch damaged blood vessels and release substances essential for blood clotting.
- Arteries carry blood away from the heart chambers; veins return blood to the heart chambers.
- Capillaries are the thin-walled vessels through which materials pass back and forth between the blood and tissues.
- The human heart consists of two atria, which receive blood from veins and two ventricles, which pump blood into the arteries.
- The heart is enclosed by pericardium and has valves that prevent backflow of blood.
- The pulmonary circulation connects heart and lungs. The systemic circulation connects the heart with the other body organs.
- In pulmonary circulation, the right ventricle pumps blood in two pulmonary arteries, and one of these carries blood to each lung. Blood circulates through pulmonary capillaries in the lungs and is then conducted to the left atrium by a pulmonary vein.
- In the systemic circulation, the left ventricle pumps blood into the aorta, which branches into arteries leading to the body organs. After flowing through the capillary networks within various organs, blood flows into vein that conducts it to the right atrium.
- The coronary circulation supplies blood to the heart muscles.
- The disorder of the heart and blood vessels is called cardiovascular disorder e.g., atherosclerosis, arteriosclerosis and myocardial infarction

EXERCISE

Section I: Multiple Choice Questions

Select the correct answer:

- The heart's upper chambers are called
A) ventricles B) atria C) valves D) arteries
- Blood components that help the body to control bleeding are
A) platelets B) red blood cells C) white blood cells D) haemoglobin
- Bicuspid valve connects
A) left atrium and right atrium B) left atrium and right ventricle
C) right atrium and left ventricle D) right atrium and right ventricle
- Which of the following chambers has the thickest walls in human heart?
A) left atrium B) right atrium C) left ventricle D) right ventricle
- The left half of the human heart:
A) has deoxygenated blood B) has oxygenated blood
C) pumps blood to the lungs D) passes blood through the right ventricle
- The pulmonary arteries carry blood to the:
A) brain B) heart C) liver D) lungs

7. Which one of the following helps to fight germs?
A) Red blood cells B) White blood cells C) Platelets D) Plasma
8. The blood vessels that carry blood from heart to the various parts of the body are called:
A) septum B) arteries C) veins D) capillaries
9. Which one of the following is a double membrane sac that covers the human heart?
A) epicardium B) pericardium C) myocardium D) endocardium
10. The alternating expansion and relaxation of the artery that you feel in your wrist is the:
A) pulse B) coronary artery C) blood pressure D) plasma
11. Nutrients are exchanged between the blood and body cells in the:
A) arteries B) capillaries C) veins D) aorta
12. Which is the largest artery in the human body?
A) pulmonary artery B) aorta C) common iliac artery D) femoral artery
13. What is the valve in the opening between the right atrium and the right ventricle called?
A) pulmonary valve B) aortic valve C) tricuspid valve D) bicuspid valve
14. Human heart is:
A) myogenic B) neurogenic C) cardiogenic D) digenic
15. Pacemaker is situated in heart
A) in the wall of right atrium B) on interauricular septum
C) on interventricular septum D) in the wall of the left atrium

Section II: Short Answer Questions

1. Write the functions of:

- a. pericardium
- b. left atrium
- c. right atrium
- d. left ventricle
- e. right ventricle
- f. bicuspid valve
- g. tricuspid valve
- h. semilunar valve
- i. septum
- j. aorta
- k. pulmonary artery
- l. pulmonary vein
- m. plasma
- n. red blood cells
- o. white blood cells
- p. platelets

2. Differentiate between:

- a. Serum and blood
- b. Artery and vein
- c. Tricuspid and bicuspid valve
- d. Systole and diastole

- e. Red blood cells and white blood cells
- f. Pulmonary artery and pulmonary vein
- 3. Why is a circulatory system necessary?
- 4. Name the three circuits of the circulatory system.
- 5. Describe coronary circuit.
- 6. Write the six functions of blood.
- 7. What are the organs that are connected to the circulatory system?
- 8. Name the types of blood vessels.
- 9. What are the types of white blood cells? Why these are called white blood cells?
- 10. In what ways does pulmonary artery differ from all other arteries?
- 11. How are the valves of human heart important?
- 12. Suggest why an injury that cuts open artery is much more dangerous than an injury to vein?
- 13. Why are valves present in veins but not in arteries?
- 14. Why are the walls of the atria thinner than the walls of the ventricle?
- 15. Why is the muscle of the left ventricle thicker than that of right ventricle?

Section III: Extensive Answer Questions

- 1. Describe the pulmonary and systemic circuits of the circulatory system.
- 2. How are the materials transported through the blood?
- 3. What are the organs connected to blood circulatory system? Explain.
- 4. What are the components of blood.
- 5. Describe the cell types found in blood.
- 6. Draw and describe the structure of human heart.
- 7. Explain the circulation of blood through the human heart.
- 8. Discuss the following heart diseases in human:
 - a. Coronary heart disease
 - b. Myocardial infarction
 - c. Angina
- 9. Explain the harmful effects of smoking related to heart diseases