Chapter

1 Circulatory System

New topic alert!
How do you feel?


Excited


Nervous

Learning Objectives

1. Figure out the components of blood
2. Understand the circulatory process throughout the body
3. Prevent circulatory system disorders by maintaining its health

Focus on

- Components of Blood
- Blood Flow in the Body
- Protecting the Circulatory System

Warm Up

Pascal and Indy are at the park after school.

Indy : Pascal, can you feel your heart beating fast after running?

Pascal : Yes! It's going *thump-thump* super fast! Why is that?

Indy : That's your heart working hard to send blood all around your body!

Pascal : Wow! So my heart is like a pump?

Indy : Exactly! It pumps blood so your body can get oxygen and energy.

Can you feel your heartbeat too? Tick (✓) your answer.

Place your hand on your chest and find out!

Yes No

Components of Blood

You all must have known that blood is the red liquid that constantly flows throughout our body. The main function of blood is to transport oxygen to every part of the body. Blood carries nutrients, metabolic waste, and contains substances to protect the body from various diseases. Blood is very important for the body that it can reflect the state of a healthy or a sick body.

Oxygen that we breathe from the air will be carried by the blood throughout the body. Blood consists of two main parts, namely the liquid part (blood plasma) and the solid part (blood cells). Blood cells consist of red blood cells (erythrocytes), white blood cells (leukocytes), and platelets (thrombocytes).

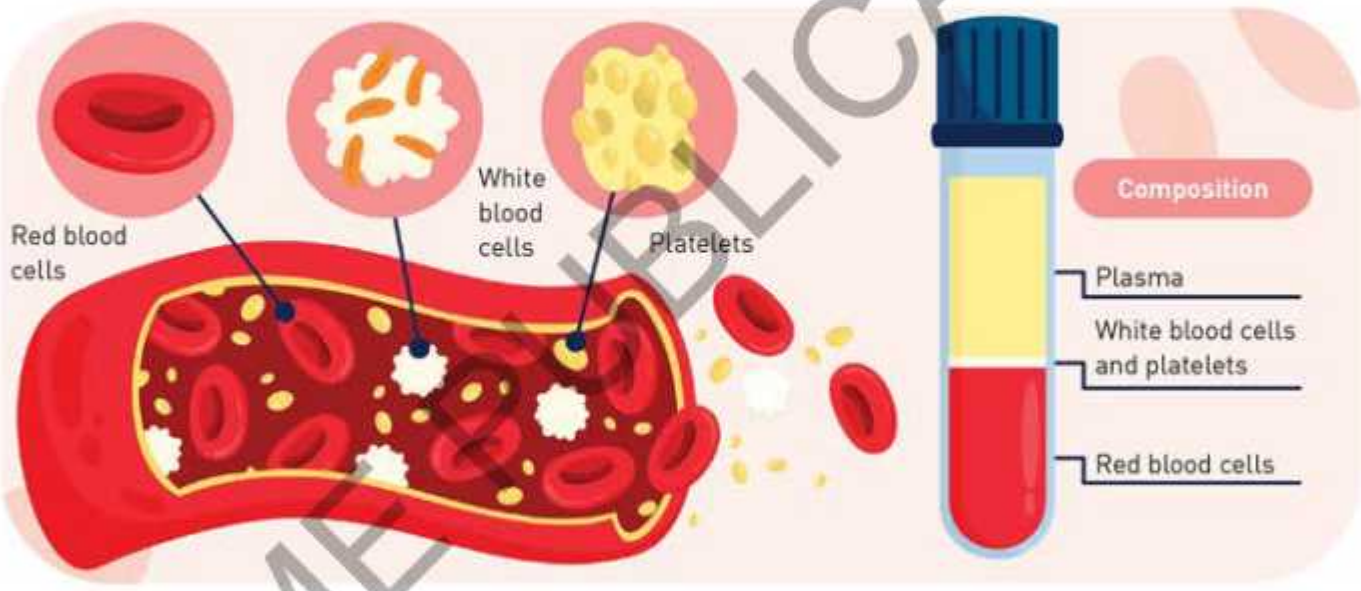


Figure 1.1 – Blood consists of blood plasma and blood cells.

Blood Plasma

Blood plasma is a pale yellow liquid that contains nutrients. Some nutrients such as sugar, protein, fat, vitamins, and mineral salts are dissolved in blood plasma. Blood plasma mainly functions to carry nutrients

Nifty Insight

Over half of your blood is made up of plasma, and most of the plasma is just water. That is why it is so important to drink enough water every day!

from the small intestine to all over the body. It is also useful for transporting carbon dioxide formed by the digestion process of the nutrients. Carbon dioxide is transported to the lungs and excreted through the respiratory tract.

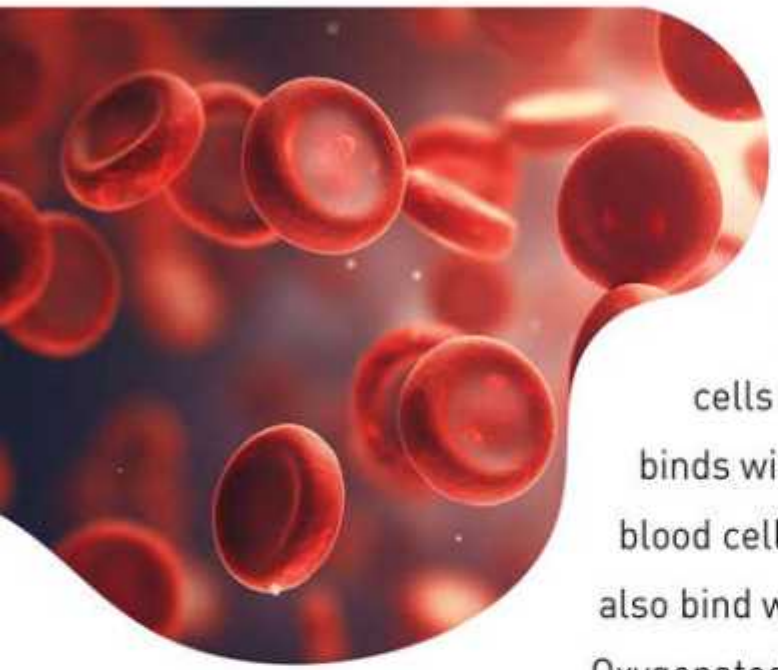


Figure 1.2 – Red blood cells are shaped like discs under the microscope.

Red Blood Cells (Erythrocytes)

Red blood cells are the largest in number compared to other blood cells. Red blood cells are shaped like discs and are slightly curved inward like a bowl in the middle. Red blood cells are red due to the protein haemoglobin that binds with oxygen. From the lungs, oxygen within red blood cells is carried to the entire body. Haemoglobin can also bind with carbon dioxide and transport it to the lungs. Oxygenated blood (contains a lot of oxygen) is bright red, while deoxygenated blood (contains a lot of carbon dioxide) is dark red.

✨ Nifty Insight ✨

Bone marrow produces about two million red blood cells every second, and those cells have an active period of about 120 days.

White Blood Cells (Leukocytes)

White blood cells are fewer but they are bigger than the red blood cells in size. Their shape is always changing because they are actively moving. Their function is to identify and combat harmful invaders like bacteria, viruses, fungi, and parasites. Those invaders will be surrounded and captured, and then eaten by the white blood cells.

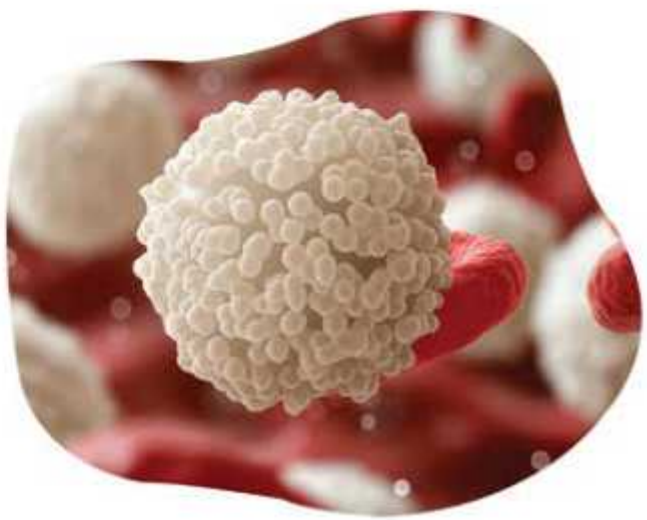


Figure 1.3 – White blood cells are actively moving to fight invaders.

Blood Platelets (Thrombocytes)

Blood platelets are irregularly shaped, easily broken, and their size is one-third of red blood cells. They play a role in blood clotting (also called coagulation). If your skin is injured, like being cut by a knife, blood platelets will release chemicals that can help speed up blood clotting.

Figure 1.4 – Thrombocytes are smaller than red blood cells.

Blood Flow in the Body

Blood can flow in the body because of the circulatory system. Before you learn how blood flows in the body, you will first learn about the circulatory system.

Circulatory Organs

Blood flows in blood vessels like water flowing in a long, small hose. In addition to blood vessels, there is one part of the body that is very important in blood circulation, namely the heart. What is the role of the heart in blood circulation? Let's read the following explanation.

Heart

Try to feel your left chest! Do you feel it pulsating? That is your heartbeat. The heart is a vital muscular organ that acts as a pump, circulating blood throughout the body.

✨ Nifty Insight ✨

Human heart's size is approximately the same as the left fist.

The heart consists of four chambers, namely the left atrium, right atrium, left ventricle, and right ventricle. Those chambers contain blood with different oxygen levels. The two upper chambers are called atria (plural for atrium). The left atrium receives oxygenated blood from the lungs. The right atrium receives deoxygenated blood from the entire body.

Meanwhile, the two lower chambers are called ventricles. The left ventricle receives oxygenated blood from the left atrium and then pumps it to the entire body. The right ventricle receives deoxygenated blood from the right atrium and then pumps it to the lungs to be excreted.

As a blood pump, the heart has strong muscles. The walls of the ventricles have thicker muscles than the walls of the atrium. This is because the ventricles pump blood, while the atrium only receives blood. The heart pumps blood endlessly. Even when resting or sleeping, the heart continues to work.

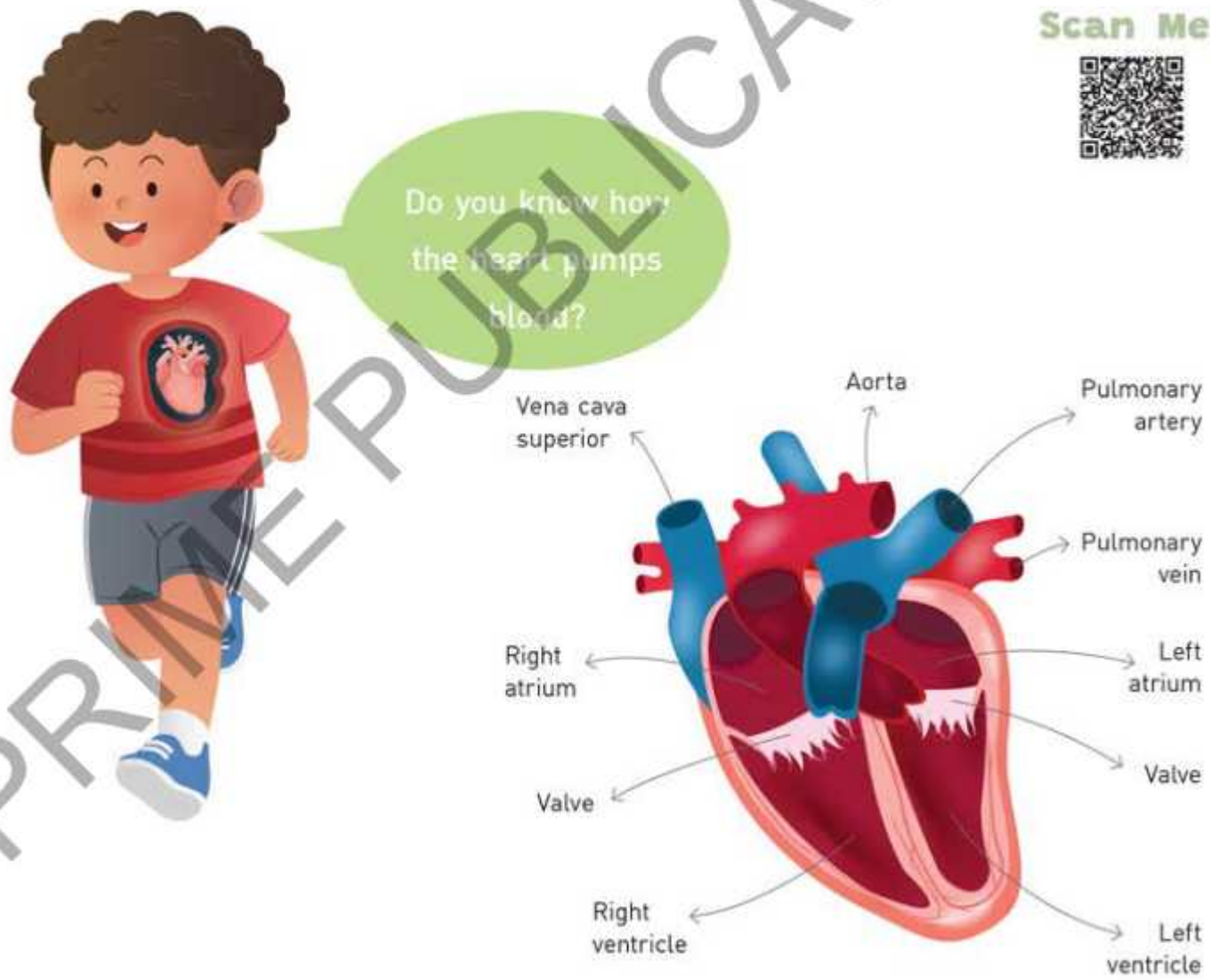


Figure 1.5 – Heart's position in the body and its components

When the heart contracts, blood will flow throughout the body and lungs. On the other hand, when the heart expands, blood will enter from all over the body and lungs into the atrium. Do you know how fast the heart works? Try placing your hand on your left chest again and feel your heartbeat. The sound and movement of the heartbeat indicate that your heart is working to pump blood. We can hear the heartbeat louder using a stethoscope.

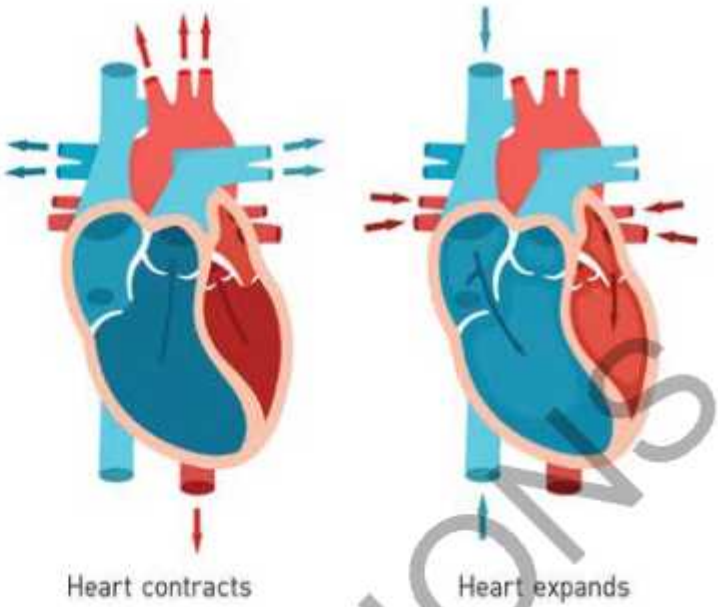


Figure 1.6 – How heart pumps blood

Nifty Insight

Your heart beats about 100,000 times every day! That's enough to pump blood all the way around your body again and again-without ever taking a break.

Try and Learn

Let's find out how your heartbeat changes when you move!

- Sit quietly and place two fingers on your wrist or chest to feel your heartbeat.
- Count how many times your heart beats in 30 seconds.
- Now, do 20 jumping jacks or jog in place for 1 minute.
- Sit back down, place your fingers again, and count your heartbeat for another 30 seconds.
- Was your heartbeat faster after exercising or before?
- Why do you think your heart beats faster when you move?

Blood Vessels

A blood vessel is a conduit in our body where blood circulates. Blood vessels include arteries, veins, and capillaries.

Arteries

Arteries carry blood from the heart to the rest of the body. These vessels carry oxygenated blood to the rest of the body. Arteries have thick, elastic walls. Aorta is the largest artery that exits the left ventricle of the heart. The aorta branches into the body's other arteries.

When the heart pumps blood, the arteries also beat, it is called the pulse. We can feel it by feeling or pressing the arteries on the wrist or the part of the neck below the ear. Can you feel it? The number of pulses we feel is the same as the number of heartbeats.

Veins

Veins carry deoxygenated blood from the entire body and return it to the heart. Veins are located close to the body's surface, making them visible beneath the skin as branching bluish lines.

Nifty Insight

Veins appear blue due to light diffusion through skin, not because blood is blue.

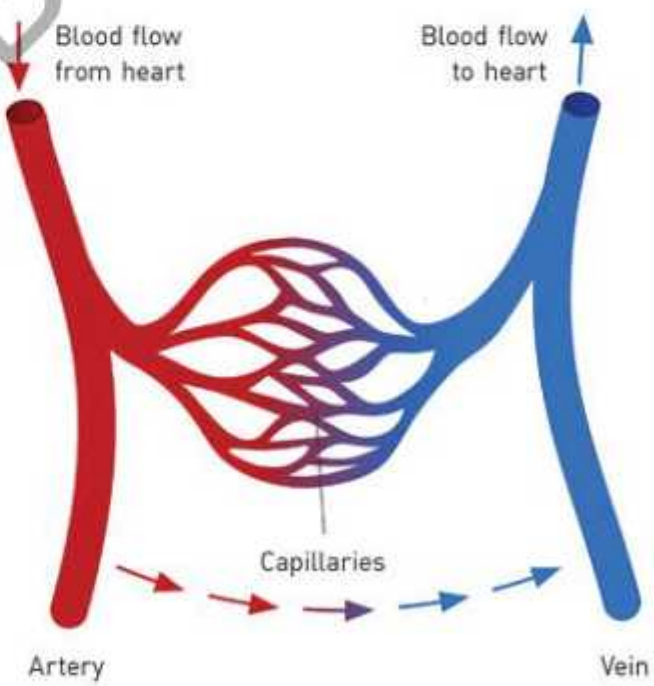


Figure 1.7 – Blood flow in human blood vessels

Capillaries

Capillaries are tiny, delicate blood vessels that connect the ends of the smallest arteries with the ends of the smallest veins. In the capillaries, water, oxygen, carbon dioxide, nutrients, and waste products are exchanged between the blood and the body's cells

Nifty Insight

If you lined up all your blood vessels, they would stretch over 96,000 kilometers-long enough to go around the world more than twice!

Remember and Recall

Tick (✓) the correct statements or cross (✗) the wrong one.

1. The heart stops working when we sleep.
2. Veins carry blood back to the heart.
3. Blood always stays in one place in the body.
4. The left side of the heart pumps blood to the whole body.
5. Arteries carry blood away from the heart.

Human Circulatory System

Blood circulates in our body through blood vessels. Therefore, it is called a closed blood circulation system. There isn't only one blood circulation system in the human body, but two, which are connected: The systemic circulation provides organs, tissues and cells with blood so that they get oxygen and other vital substances and discharge carbon dioxide and waste. The pulmonary circulation is where the fresh oxygen we breathe in enters the blood. In other words, pulmonary circulation is a short loop from the heart to the lungs and back again, while the systemic circulation carries blood from the heart to all the other parts of the body and back again. How does blood flow in those two circulations then?

Pulmonary Circulation

Pulmonary circulation moves blood between the heart and the lungs. Within the heart, blood from the right ventricle of the heart is pumped through the Pulmonary system to the lungs, and this blood then returns to the left atrium of heart.

From the Heart to the Lungs

The heart pumps deoxygenated blood back to the lungs. This blood is rich in carbon dioxide and is pumped into the tiny capillaries in the lungs, where the carbon dioxide is exchanged with oxygen from the air that was breathed by the lungs.

From the Lungs to the Heart

The now oxygenated blood that leaves the lung capillaries is collected in the arteries, which return it to the heart. Within the heart, this oxygenated blood will then enter the systemic circulation for distribution to the body.

Systemic Circulation

Systemic circulation moves blood between the heart and the rest of the body. Within the heart, blood from the left ventricle is pumped to the body through the systemic system, and this blood then returns from the body to the right atrium.

From the Heart to all Parts of the Body

The heart pumps oxygenated blood throughout the body. Blood carries nutrients from the digestive

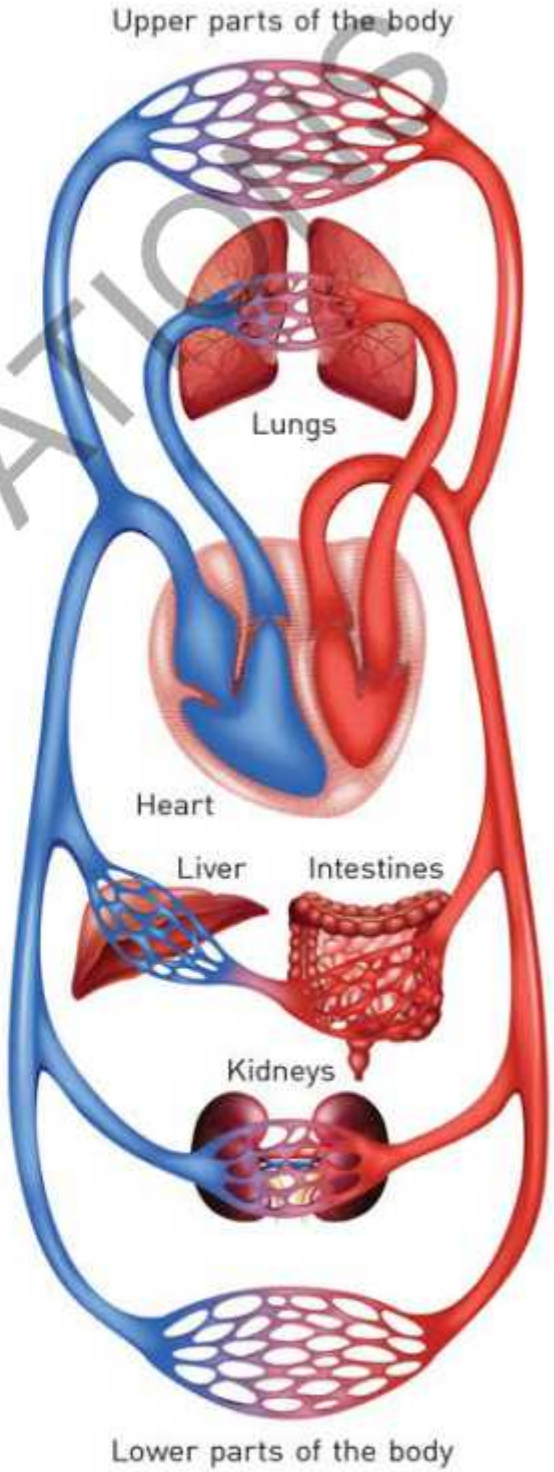


Figure 1.8 – Blood circulation path

tract and distributes them to the body's cells. Oxygen, nutrients, and water in the cells are used for producing energy.

From all Parts of the Body to the Heart

Blood that has circulated in the body carries carbon dioxide and waste substances from the body cells. On its way to the heart, blood containing carbon dioxide and waste will pass through the kidneys and liver. Waste will be removed from the body. Blood with carbon dioxide is returned to the heart.

Think and Share

Why is it important for blood to carry oxygen to every part of your body?

Protecting the Circulatory System

You have learned how important blood circulation is for our body. However, sometimes blood circulation in our body can be disturbed. What are those disturbances, and what can we do to prevent them?

Blood Circulatory Disorders

Disorders in human blood circulation can disrupt the process of distributing oxygen and nutrients throughout the body. Can you imagine the consequences? Yes, the body will be weak and lack nutrition, and it can even cause death. Generally, disorders in human blood circulation are caused by unhealthy lifestyles, such as rarely exercising, lack of nutritious food intake, and consuming too much fatty food. Here are some disorders that can occur in human blood circulation.

Clogged Artery

Clogged arteries are commonly caused by a buildup of a substance called plaque on the inner walls of the arteries. Plague can be in the form of fat deposits or calcium deposits. The layer of fat that accumulates in the arteries over time causes

Figure 1.9 – Fat build-up in the blood vessels makes clogged artery.

the walls of the arteries to narrow. This blockage can result in the cessation of blood flow. If the blood flow to the brain is blocked, the brain will be disturbed and could result in a stroke. If the blood flow to the heart is blocked, coronary heart disease may occur, which can lead to a fatal heart attack.

Nifty Insight

Eating too much fatty food or smoking can clog your arteries, making it harder for blood to flow and increasing your risk of heart disease or stroke.

Anaemia

Anaemia is a condition where the body lacks haemoglobin in the red blood cells. This reduces the blood's ability to deliver oxygen to the body's tissues, leading to fatigue, weakness, and other symptoms. Anaemia can be caused by various factors such as vitamin deficiencies, chronic diseases, genetic conditions and mostly due to iron deficiency. Iron deficiency can occur due to not eating enough foods containing iron or losing a lot of blood. Anaemia sufferers should focus on eating foods that contain a lot of iron and vitamin C. Vitamin C is very useful in causing iron to be more easily absorbed by red blood cells.

Figure 1.10 – Consuming iron-rich foods helps prevent anaemia.

Leukaemia

Leukaemia is a type of cancer that is caused by the abnormal production of white blood cells. This overproduction of white blood cells can interfere with the body's ability to produce healthy blood cells and can also impair the immune system's ability to fight off infections. Leukaemia is usually caused by hereditary or genetic factors. The primary treatment for this disorder is to take medication to kill leukaemia cells.

Maintaining a Healthy Circulatory System

Disorders of the circulatory organs can be prevented by healthy living habits and consuming nutritious food. Let's do the following things to avoid circulatory disorders.

- Exercise regularly because it makes the heart muscles get stronger and improves the heart's ability to pump blood.
- Avoid foods that are harmful to health, such as fatty foods.
- Avoid cigarettes, alcoholic beverages, and illegal drugs.
- Get enough rest.
- Eat foods that are part of a healthy and nutritious diet.

Figure 1.11 – Exercise regularly is one of the efforts to keep the circulatory system healthy.

Teacher's Corner

Ask students to feel their heartbeat before and after exercise. Use red and blue arrows to show blood flow in the heart. Let students act as blood moving from the heart to the lungs and back. Remind them that good food and exercise keep the heart strong. Use a stethoscope, if available, to let students listen to a heartbeat.

Key Terms

Blood	:	The red liquid that carries oxygen and nutrients.
Blood vessels	:	Tubes that carry blood through the body.
Circulatory system	:	The system that moves blood around the body.
Deoxygenated blood	:	Blood with little oxygen, going back to the lungs.
Heart	:	The organ that pumps blood around the body.
Oxygenated blood	:	Blood rich in oxygen from the lungs.

Points to Reflect

- The human circulatory system consists of the heart, blood vessels, and blood.
- The heart consists of four chambers, two ventricles and two atria. The atria and ventricles are separated by valves.
- There are three types of blood vessels, namely arteries, veins, and capillaries.
- The human circulatory system is a closed and double circulatory system.
- Double blood circulation consists of pulmonary blood circulation and systemic blood circulation.
- Disorders of the circulatory system include coronary heart disease and stroke.

Assess Yourself

A. Cross (X) the correct answer.

1. The component of blood that transports nutrients is _____.

a. blood plasma
b. red blood cells
c. white blood cells
d. blood platelets

2. Study the following blood functions.

1) Transport carbon dioxide.
2) Fight bacteria.
3) Play a vital role in blood clotting.
4) Act as an antibody.

The correct functions of white blood cells are _____.

a. (1) and (2)
b. (1) and (3)
c. (2) and (4)
d. (3) and (4)

3. The blood vessels that connect arteries and veins are _____.

a. capillary vessels
b. artery vessels
c. vein vessels
d. aortas

4. Stroke is a disorder of the blood vessels in the _____.

a. heart
b. lungs
c. liver
d. brain

5. One of the right ways to maintain a healthy circulatory system is _____.

a. daily dialysis
b. eat as much as possible
c. exercise regularly
d. reduce rest

6. A lifestyle that causes coronary heart disease is _____.

a. exercising every morning
b. eating fatty foods

c. eating vegetables and fruits every day

d. going to sleep at 9 p.m.

7. The function of red blood cells is to _____.

a. bind oxygen

b. carry food

c. fight germs

d. do blood clotting

8. The circulatory organs in humans are _____.

a. heart and lymph vessels

b. heart and lungs

c. heart and nerves

d. heart and blood vessels

9. Human blood circulation is _____.

a. an open blood circulation

b. a pulmonary blood circulation

c. a systemic blood circulation

d. a closed and double blood circulation

10. Circulatory disorder caused by reduced count of red blood cells is _____.

a. stroke

b. anaemia

c. leukemia

d. hypertension

B. Fill in the blanks with the correct words from the box. Intellectual Development

thrombocytes	discs	the heart	stroke	fat

1. The blood cells that play a vital role in blood clotting are _____.

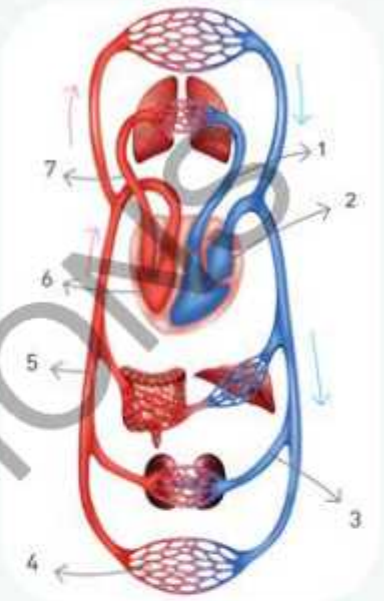
2. Red blood cells are shaped like _____.

3. The body organ that pumps blood throughout the body is _____.

4. A brain disorder caused by blockage of blood vessels is called _____.

5. Heart attacks are caused by the accumulation of _____ in the blood vessels in the heart.

C. **Study the picture to answer the following questions.** Picture-Based Analysis



1. The vessel through which oxygen-rich blood passes is indicated by the number _____.
2. The vessel through which carbon dioxide-rich blood passes is indicated by the number _____.
3. The heart organ that pumps oxygen-rich blood is indicated by the number _____.
4. The order of pulmonary blood circulation is _____.
5. The order of systemic blood circulation is _____.

D. **Answer the following questions.** Critical Thinking

1. Why is the muscle in the ventricles of the heart thicker than the muscle in the atrium of the heart?

2. Evan likes to eat deep-fried foods. He does not like to eat vegetables and fruits. Evan also rarely exercises. In your opinion, what are the effects of Evan's lifestyle on his circulatory system health?

Life Skills and Subject Integration

E. **List three things you can do in your daily life to keep your heart and circulatory system healthy.** Integrated to English

Think Green

Walking, running, or cycling helps your heart stay strong.
When you move instead of using a car, you can also help reduce the pollution in the air.
Eating fresh, local food keeps your heart healthy and saves energy.
Let's care for our heart and the Earth at the same time!

Figure 1.11 – A healthy Earth gives us a clean environment to exercise in.