

About the heart

A basic introduction to the heart and circulatory system

- The heart is at the centre of the circulatory system, pumping blood to deliver oxygen and nutrients to all areas of the body, and removing waste products.
- The heart works automatically, without us having to consciously control it.
- The heart is a unique type of muscle, perfect for its role: it never tires and never needs to rest.

What does the circulatory system do?

The heart is at the centre of the circulatory system. This system is vital: it delivers oxygen and nutrients carried in the blood to cells of the body to 'power' them, and it removes waste products from the blood.

For a circulatory system to work, it needs several key components:

- fluid to circulate around the body, carrying oxygen and nutrients (the blood);
- a network of connected tubes to transport the fluid around the body (blood vessels);
- a series of 'gates' to ensure the fluid flows in the correct direction (valves in the blood vessels); and
- a pump to drive the fluid around the body and to the lungs (the heart).

For each complete 'circuit' blood goes through the heart twice (which is known as 'double circulation'):

- from the heart to the lungs and back to the heart (known as pulmonary circulation); and
- from the heart to the cells of the body and back to the heart (known as systemic circulation).

How the heart powers the body

All cells and organs in the body need oxygen and an energy source (glucose) to work. And as they work they produce waste products such as carbon dioxide which must be removed from the body. The circulatory system works with the respiratory system (the nose, trachea or 'windpipe', and lungs) and digestive system (the stomach and intestines), to achieve this.

As we breathe in, oxygen enters the body through the lungs. It is picked up from the lungs and carried around the body by red blood cells (and is called 'oxygenated blood'). Glucose enters the blood as it passes through the digestive system. Oxygen and glucose are then delivered to the cells and organs of the body for them to work. Once oxygen has been delivered, the 'deoxygenated' blood (without oxygen) needs to return to the lungs to pick up more oxygen. As it does this, the waste product carbon dioxide is released through the lungs and is breathed out.

The role of blood vessels

Blood is carried around the body in blood vessels.

- **Arteries** generally carry blood away from the heart towards the lungs and the body. The blood is under high pressure (in order to reach all areas of the body), so the walls of arteries are thick and rigid, and have a muscular layer which allows them to restrict and relax as necessary.
- **Capillaries** are the smallest blood vessels and their thin walls allow oxygen and nutrients in the blood to pass into the surrounding cells and organs, and waste products to pass back into the blood.
- **Veins** generally carry blood towards the heart from the body and the lungs. Blood returning to the heart is under low pressure, so veins have valves within them to ensure blood moves forward and to prevent it flowing backwards.

Types of muscle found in the body

There are three types of muscle in the human body.

- **Skeletal** (or striped) muscle is found attached to bones, under the skin and in the diaphragm (the strong muscle under the lungs that helps you breathe). Skeletal muscle is consciously controlled and works in short, powerful bursts. An example of skeletal muscles are leg muscles used to walk.
- **Visceral** (or smooth) muscle is found in areas of the body that are hollow - such as your digestive tract, respiratory system and blood vessels. It is automatically controlled (works without having to think about it). An example of visceral muscle at work is your intestines moving food through your digestive system.
- **Cardiac** (or heart) muscle is unique and only found in the heart. It is made up of specialised heart muscle cells called myocytes. Myocytes are branched and connected together so that they are synchronised (work together) when they contract and relax. Like all muscle cells, myocytes communicate by electrical signals, which are spread quickly. This muscle is regulated by the autonomic nervous system (which is automatic and unconscious, and regulates functions such as heart beat, breathing and digestion). Unlike other types of muscle, heart muscle works constantly without tiring.



The structure of the heart

The heart is a muscular pump that circulates blood through blood vessels by rhythmically contracting and relaxing. The heart sits in a cavity behind the sternum (breastbone). The average adult heart is around 12cm long from top to bottom.

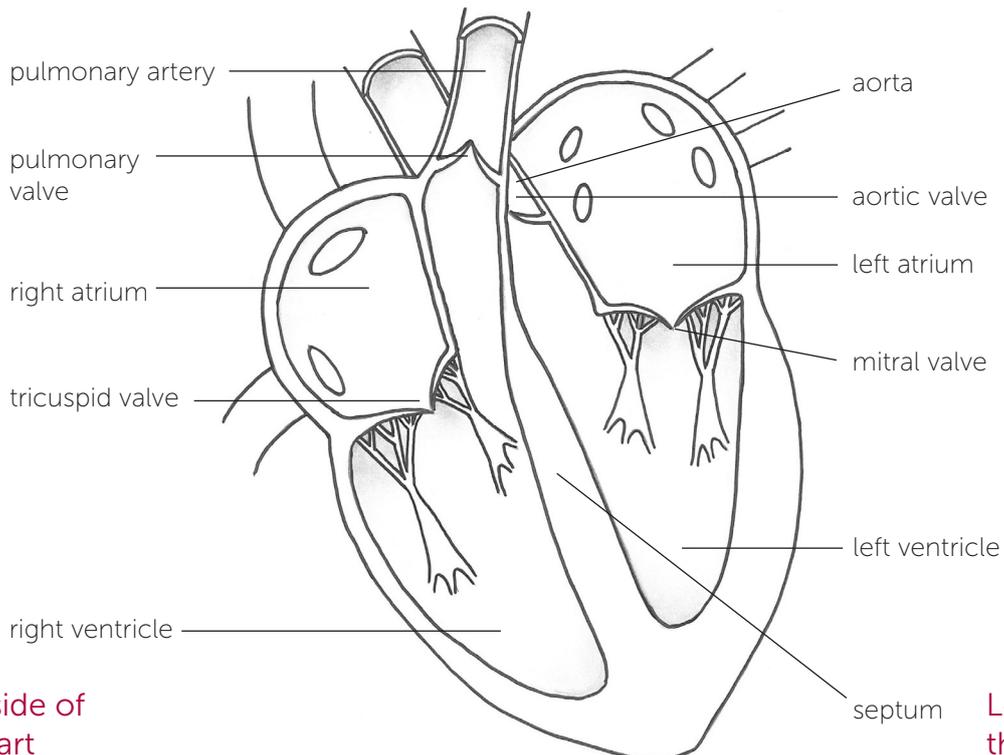
The heart is made up of four chambers, two on the right and two on the left. Although they work in time with each other, the two sides are separated by a muscular wall called the **septum**.

The upper chambers are the right and left **atrium**. Their muscle walls are thin and elastic, and they collect blood coming into the heart.

The lower chambers are the right and left **ventricles**, which receive blood from the atria above. Their muscular walls are thicker than the atria because they have to pump blood out of the heart. Although the left and right ventricle are similar in structure, the walls of the left ventricle are thicker and stronger. This is because the left ventricle has to pump blood at a higher pressure so that it reaches all areas of the body (including the fingers and toes) but the right side only has to pump blood to the lungs. This means that the heart is not quite symmetrical.

The two chambers on the right receive blood from the body and pump it to the lungs, where it receives oxygen. The two on the left receive the blood from the lungs, newly filled with oxygen, and pump it out to the body, where the oxygen is used up.

The structure of the heart (as if you were looking in a mirror).



Right side of
the heart

Left side of
the heart

The heart needs a supply of oxygen and glucose to work. This is provided by blood carried to the heart by coronary arteries which lie on the outer surface of the heart, and away from the heart by cardiac veins.

The heart and blood pressure

Blood pressure is one of the ways in which the heart's function is measured. It is measured in millimetres of mercury, and given as two numbers (such as 120/80mmHg). The top number is the pressure of blood when the heart beats (and pumps blood out of the heart). The bottom number is the pressure of blood when the heart is resting between beats.

The role of heart valves

To ensure that blood moves in the right direction and doesn't flow backwards, the heart has a system of valves. These valves are flaps of fibrous material, shaped to open under high pressure (to allow blood to flow through) and close under low pressure (to stop blood flowing backwards).

- On the right, between the right atrium and right ventricle is the **tricuspid** valve. It has three cup-shaped flaps.
- The pulmonary artery has a valve, to direct blood leaving the right ventricle (pulmonary valve).
- On the left, between the left atrium and left ventricle is the **mitral** valve. It is also known as the bicuspid valve as it has two cup-shaped flaps. When the heart contracts, the mitral valve is forced closed.
- The aorta has an aortic valve, to direct blood leaving the left ventricle.



The cardiac cycle

The heart beats around 70 times each minute and pumps over 7,000 litres of blood per day. The flow of blood from the heart to the lungs, and from the heart a second time to the rest of the body, is called the 'cardiac cycle'. It has two phases:

- **diastole** - relaxation of the muscle to allow the chambers of the heart to fill with blood; and
- **systole** - contraction of the muscle that pushes out around 60% of the blood from the chamber.

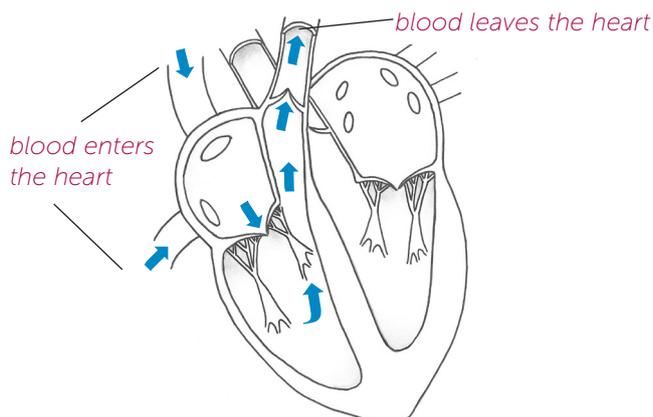
These phases happen in sequence to move the blood into and out of the heart chambers.

Pulmonary circulation

This happens on the **right** side of the heart and takes blood from the body to the heart and then from the heart to the lungs to pick up oxygen and get rid of carbon dioxide (a waste product).

- Deoxygenated blood returns from the body (where it has used up oxygen) to the heart. It enters the right atrium through two veins called the superior and inferior vena cava.
- The atrium is relaxed (diastole) as blood enters. As the atrium fills, the pressure inside rises. The tricuspid valve (between the atrium and ventricle) is closed to stop blood entering the ventricle.
- Once full, the pressure inside the atrium causes the tricuspid valve to open, and blood flows into the right ventricle. At the same time, the muscles of the atrium wall contract (systole) to push the blood into the ventricle.
- As blood flows in, the muscles of the ventricle are relaxed (diastole) and the pressure inside the ventricle is low. This helps the blood to flow in. The semi-lunar valve (in the pulmonary artery) is closed to stop blood flowing out of the ventricle.
- As the ventricle fills with blood, the pressure inside rises. This pressure then causes the semi-lunar valve to open. At the same time, the muscles of the ventricle wall contract (systole) and force blood out through the pulmonary artery. The tricuspid valve stays shut to stop blood flowing back into the atria.
- Blood then enters the lungs to pick up oxygen and get rid of carbon dioxide.

Blood flow through the right side of the heart.



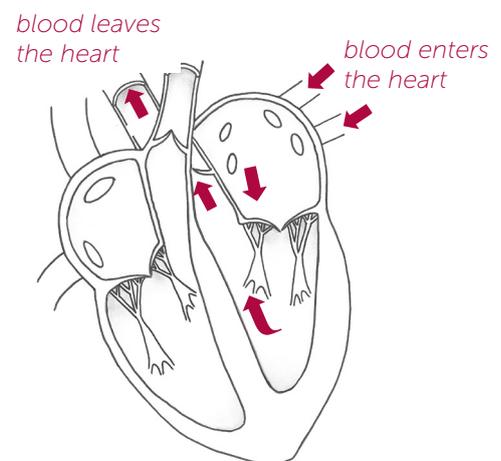
Systemic circulation

This happens on the **left** side of the heart and takes oxygenated blood from the lungs to the heart and then from the heart to the body.

- Blood leaves the lungs and returns to the heart, entering the left atrium through veins called the pulmonary veins.
- The atrium is relaxed (diastole) as blood enters. As the atrium fills, the pressure inside rises. The mitral valve (between the atrium and ventricle) is closed to stop blood entering the ventricle.
- Once full, the pressure inside the atrium causes the mitral valve to open, and blood flows into the left ventricle. At the same time, the muscles of the atrium wall contract (systole) to push the blood into the ventricle.
- As blood flows in, the muscles of the ventricle are relaxed (diastole) and the pressure inside the ventricle is low. This helps the blood to flow in. The semi-lunar valve (in the aorta) is closed to stop blood flowing out of the ventricle.
- As the ventricle fills with blood, the pressure inside rises. This pressure causes the semi-lunar valve to open. At the same time, the walls of the ventricle contract (systole) and force blood out through the aorta. The mitral valve stays shut to stop blood flowing back into the atria.
- Blood then flows to the body to deliver oxygen and nutrients.

Although this describes the flow of blood through the heart in one 'circuit' of circulation, both sides of the heart are working at the same time (both atria fill and contract at the same time and both ventricles fill and contract at the same time).

Blood flow through the left side of the heart.



In these illustrations
Deoxygenated blood is shown in blue
Oxygenated blood is shown in red.



The sound of a heart beat

The sound of a heart beat is sometimes described as 'lub-dub'. This sound is caused by the closing of the heart valves. The 'lub' is made by the closing of the mitral and tricuspid valves, and the 'dub' is the closing of the two semi-lunar valves.

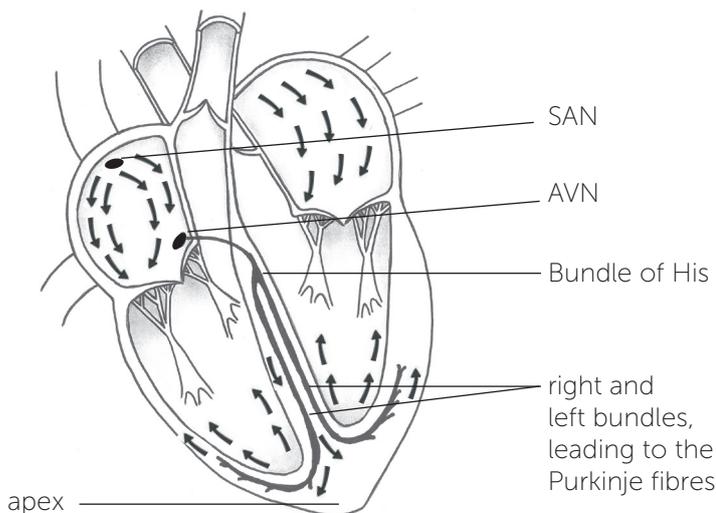
How is the cardiac cycle controlled?

The cardiac cycle is controlled from within the heart itself, from an area of specialised muscle cells called the sinoatrial node or 'SAN'. The SAN generates and conducts electrical impulses which make the heart muscles contract and relax (or 'beat'). For this reason, the SAN is sometimes referred to as the 'pacemaker'.

How the cycle is generated

- Electrical activity is spontaneously generated by the SAN, at the top of the right atrium.
- The electrical activity spreads through the muscle of both atria, making them contract.
- The electrical activity is stopped from spreading to the ventricles by a layer of connective tissue. Instead, the activity reaches a second group of specialised muscle cells called the atrioventricular node (or AVN), between the two atria and the top of the ventricles.
- The AVN passes the electrical activity down a group of muscle fibres called the Bundle of His, which sits in the septum - the muscular wall between the two ventricles.
- From the Bundle of His, the activity spreads into the left and right bundles branches and then to the smaller muscle fibres in the ventricle walls (the Purkinje fibres). This causes the ventricle walls to contract from the bottom point of the heart (the apex) upwards, pushing the blood out of the heart.

How the SAN and AVN control the cardiac cycle



Heart rate is influenced and controlled by different mechanisms in the body which, in turn, influence the SAN and AVN and their involvement in the cardiac cycle. So, for example, when someone is exercising (such as running) the muscles of the body need higher oxygen levels than normal. Therefore the heart beats faster to get more oxygen to the body.

The heart and cardiomyopathy

Cardiomyopathy is a disease of the heart muscle. ('Cardio' means heart, 'myo' means muscle and 'pathy' means disease.) It affects the heart's ability to pump blood around the body. This can be because it affects the structure of the heart, or the electrical messages that control how the heart works.

What next?

You may be reading this factsheet because you, or someone you know, have been told that you may have cardiomyopathy. Or perhaps you have been recently diagnosed. It can be a difficult time and you may feel overwhelmed. You may have read information about the condition that has really worried you. It is natural to have lots of questions, and you may want to talk to someone who understands. Although the possibility of a diagnosis of cardiomyopathy may feel devastating, with the right information and support most people can live full and active lives.

There is a lot of information in this factsheet, but you don't need to read it all in one sitting. You may like to keep it and refer back to it another time. Or you may like to take it to your doctor's appointments with you.

We're here for you

At Cardiomyopathy UK we offer help and support for you and your family. We have information about each type of cardiomyopathy as well as diagnosis, treatment and lifestyle issues. Look on our website or call us for more information. Call our helpline to talk to our cardiomyopathy support nurses. We can put you in contact with other people affected by cardiomyopathy through our support groups, peer support volunteers and social media. Contact us for more about our services, or look online.

Cardiomyopathy^{UK}

the heart muscle charity

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