



# The cardiovascular system

Training resource for support workers



# The cardiovascular system

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## 3.1 Aim of the workbook

The aim of this workbook is to introduce the Healthcare Support Worker (HCSW) to the structure and function of the cardiovascular system.

## 3.2 Learning outcomes

By the end of this workbook you will be able to:

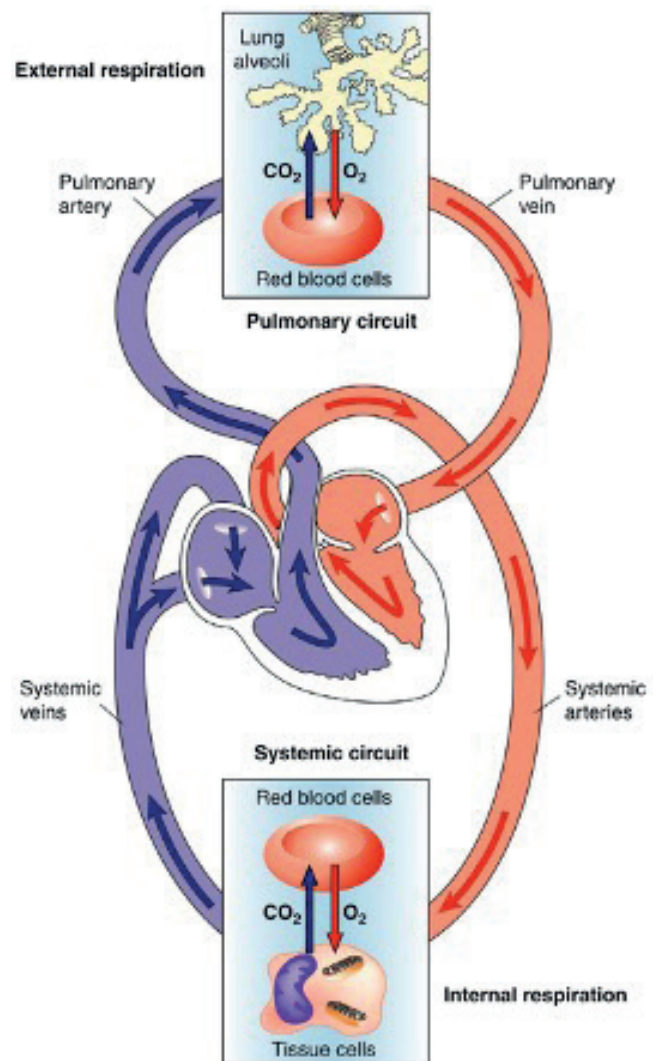
- **Describe** the structure and function of the cardiovascular system.
- **Describe** the components of blood and their function.
- **Explain** what is meant by blood pressure and describe normal values.
- **Explain** the function of the coronary arteries and outline the effects of coronary artery disease.
- **Explain** the purpose of cardiovascular rehabilitation.

## 3.3 The cardiovascular system

The cardiovascular system is the heart and the body's blood-transporting network of arteries, veins and smaller vessels. The cardiovascular system is responsible for carrying oxygen and vital nutrients to all parts of the body.

Blood is continuously pumped out from the heart and around the system in two circuits.

- **The arterial system** (pictured in red) delivers oxygenated blood from the heart to the tissues of the body, where the oxygen is given up and used by the tissues to provide energy and nutrition.
- **The venous system** (pictured in blue) returns deoxygenated blood to the heart and lungs via the network of veins, and enables removal of harmful waste from the tissues.



Circulation of blood via the arteries and veins

The heart pumps venous blood to the lungs via the pulmonary arteries. Here the blood is pumped into tiny blood vessels called capillaries, which surround little air sacs of the lungs called alveoli. Here, the capillaries allow gases in the blood to be exchanged – oxygen that is inhaled enters the tiny blood vessels and returns to the arterial system for use by the body, and carbon dioxide, the by-product of metabolism is exhaled.

### Evidence

Describe the function of the cardiovascular system

## 3.4 Names and function of the main blood vessels

- **Aorta** This main artery from the heart carries oxygenated blood to all body parts except the lungs.
- **Pulmonary veins** These veins transport oxygenated blood from the lungs back to the heart.
- **Pulmonary artery** The pulmonary artery transports de-oxygenated blood to the lungs.
- **Inferior vena cava** This major vein transports blood from the lower parts of the body back to the heart.
- **Superior vena cava** This major vein transports blood from the upper parts of the body back to the heart.
- **Portal vein** The portal vein transports blood from the digestive system to the liver.

## Activity

Name the blood vessels and what they do

## Chambers of the heart

The heart is divided into four chambers which are divided by septa (tissue wall). These are pictured in the diagram below:

**Right atrium** de-oxygenated blood from the body enters this chamber via the inferior and superior vena cava (1). Blood flows from here (2) into the right ventricle (3)

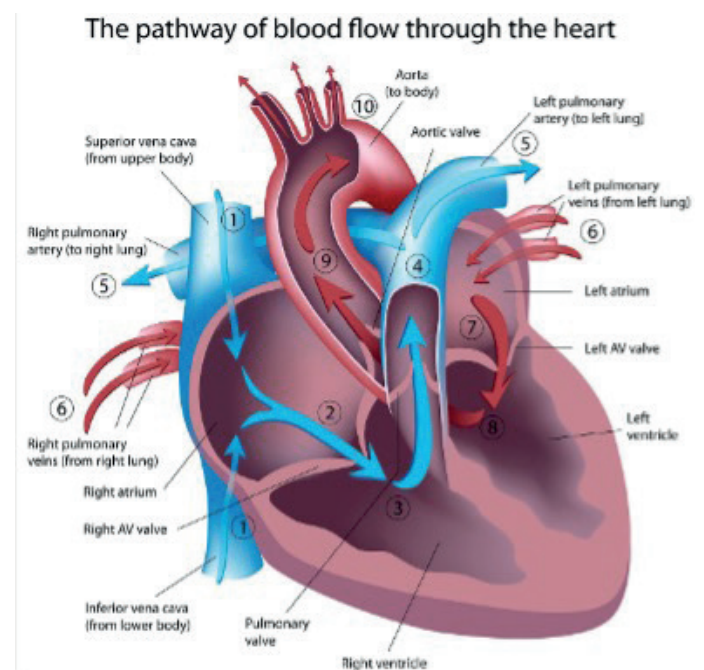
**Right ventricle** de-oxygenated blood is pumped from here (3) to the lungs via the pulmonary artery (4)

**Left atrium** oxygenated blood from the lungs returns to the left atrium (7) via the pulmonary veins (6). Blood flows from here (7) into the left ventricle (8)

**Left ventricle** oxygenated blood is pumped from here (8) to the body via the aorta (10)

## 3.5 The heart

The heart is a muscular organ which is pyramidal in shape. It lies within the thoracic cavity between the lungs. Deoxygenated blood flows into the right side of the heart, which pumps it to the lungs to pick up oxygen. The deoxygenated blood is returned to the left side of the heart which then pumps it around the body.



## Valves of the heart

Between each chamber of the heart is a valve that allows one-way flow of blood through the heart, and prevents backflow of blood;

The **mitral valve** (also known as the bicuspid valve or left atrioventricular (AV) valve) and the **tricuspid valve** (also known as the right AV valve) are sited between the **atria** and **ventricles** on the left and right sides of the heart. The **aortic and pulmonary valves** are sited at the exits of the left and right ventricles.

These valves may become diseased and can be surgically replaced by artificial valves.

Left ventricle

Right ventricle

Mitral valve

Tricuspid valve

Aortic valve

Pulmonary valve

## Evidence

In your own words, describe and name **the chambers and valves of the heart and what each does.**

Left atrium

Right atrium

## What makes the heart contract?

Unlike skeletal muscle cells that need to be stimulated by nerve impulses to contract, cardiac muscle cells can contract all by themselves.

However, if left to their own devices, cardiac muscle cells in different areas of the heart would beat at different rates. Muscle cells in the ventricles would beat more slowly than those in the atria.

Without some kind of unifying function, the heart would be an inefficient, uncoordinated

pump. So, the heart has a tiny group of cells that are responsible for co-ordinating heart rate across the heart. It starts each heartbeat and sets the heartbeat pace for the whole heart.

Damage to these cells can result in a slower heart rate. When this is a problem, an operation is often performed to install an artificial pacemaker, which takes over their role. Some patients in your care may have artificial pacemakers inserted just under the skin on their chest.

### 3.6 Blood

Blood is composed of tissue cells and a fluid known as plasma, which is mostly water but also contains various substances such as proteins and nutrients. The average volume of blood in an adult human is about 5 litres (11 pints).

There are also several types of blood cell: red blood cells, white blood cells and platelets; the most numerous being red blood cells.

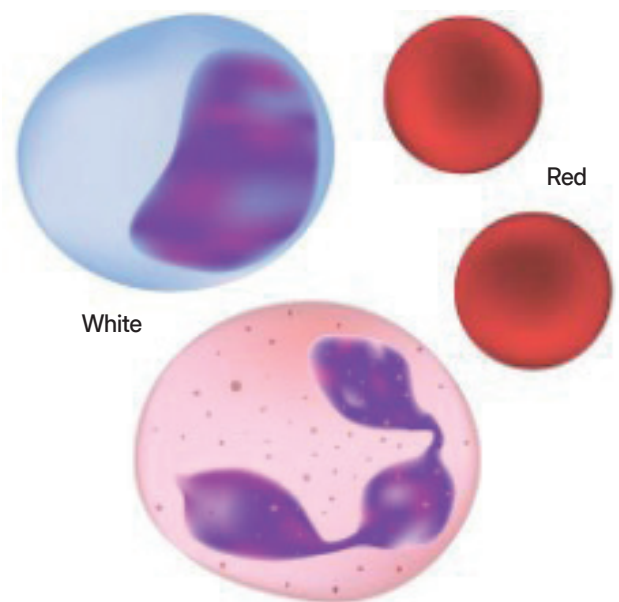
#### Red blood cells

The main role of red blood cells is to carry oxygen from the lungs to the tissues.

The main component of red blood cells is haemoglobin, made up of an iron-bearing red pigment and a protein called globin.

They are concave in shape to increase the surface area of the cells to allow them to absorb oxygen from the lungs with maximum efficiency.

Their concave surfaces give them a large surface area for the transportation of haemoglobin.



#### White blood cells (leucocytes)

The main role of white blood cells is to protect the body against infection from invading organisms.

#### Platelets

The blood contains millions of tiny platelets. Their purpose is to clump together to seal a damaged or cut blood vessel, forming a clot that prevents blood loss.

## Evidence

Name the components of blood and explain their functions

lymphocytes, which respond to infection or cell abnormalities in a number of different ways.

**Lymph** is a watery fluid that leaks out of blood vessels and accumulates in the spaces between the cells of the body tissues. Lymph is circulated by the action of body muscles, which pushes the fluid through a series of one-way valves. When there is a blockage, for example when lymph nodes have been removed by surgery, patients may suffer from severe swelling of a limb because the lymph fluid can no longer be removed. This type of swelling is common after breast surgery where the lymph nodes under the arm have been removed.

## Evidence

Describe the functions of the lymphatic system

### 3.7 The lymphatic system

The lymphatic system comprises of various tissues, vessels and nodes containing white blood cells and is a major part of the immune system. This immune system guards against invasion by disease-causing organisms. It is based on specialised white cells called

## 3.8 Blood pressure

Blood pressure is the force of blood against the walls of the arteries. Blood pressure is recorded as two numbers:

- **systolic pressure** (as the heart beats) over
- **diastolic pressure** (as the heart relaxes between beats)

The measurement is written one above or before the other, with the systolic number on top and the diastolic number on the bottom. For example, a blood pressure measurement of 120/80 mm Hg (millimetres of mercury) is expressed verbally as '120 over 80'.

Normal blood pressure is less than (<) 120 mm Hg systolic and (<) less than 80 mm Hg diastolic.

### **Low blood pressure (hypotension)**

Low blood pressure, also known as hypotension is where the pressure in the arteries is abnormally low. Naturally low blood pressure is unlikely to cause any symptoms but when it drops too low, it can restrict the amount of blood flowing to the brain and other vital organs. This can cause fainting, dizziness and light-headedness.

Low blood pressure can be a result of dehydration, sepsis, trauma, heart failure or a dramatic loss of blood after something

like a road accident; in this instance if not treated quickly, oxygen is not delivered to the brain and this is fatal.

### **High blood pressure (hypertension)**

During activity the blood pressure rises to supply blood faster to the hard working muscles. This is caused by the body producing adrenaline, the so-called 'fear, flight or fright' hormone.

Hypertension means high blood pressure. This condition is defined as a resting blood pressure of higher than about 140/90 mm Hg. In the United Kingdom over 10 million people have hypertension.

Hypertension is a problem because it puts great strain on the heart and can also cause tiny blood vessels to break. If this happens in the brain it leads to a stroke. A blood clot forms and deprives a part of the brain of blood. This damages nerve cells and can lead to paralysis or even death.

People with hypertension should alter their lifestyle to take more exercise and eat a balanced diet with a high fruit and vegetable intake, low levels of saturated fat and salt and limited amounts of alcohol. Medication can also help manage this condition.

## Evidence

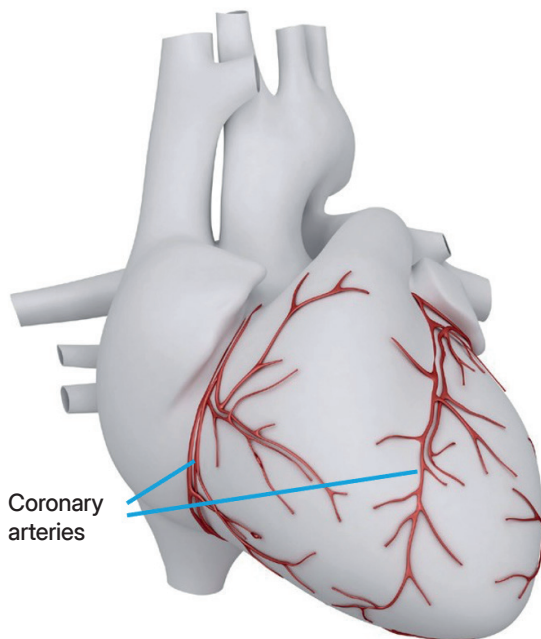
Explain what is meant by blood pressure and what happens when it is too high or too low

The blood supply that provides oxygen and nutrients to the heart is provided by blood vessels that wrap around the outside of the heart.

These are known as the **coronary arteries** and are pictured bottom left.

## 3.9 Coronary artery disease

Coronary artery disease is a serious condition affecting the arteries that provide the heart muscle with blood. Here, the arteries become blocked, a condition usually caused by the build up of plaque (deposits of fat-like substances) in a process called atherosclerosis.



### Oxygen supply to the heart

Although the heart is continually filled with blood, this blood doesn't provide the heart with oxygen.

The plaque can eventually burst, tear or rupture, creating a 'snag' where a blood clot forms and blocks the artery. The muscle of the heart no longer has sufficient blood supply, resulting in angina or even a heart

attack. If the blood supply is cut off for more than a few minutes, muscle cells suffer permanent injury and die. This can kill or disable someone, depending on how much heart muscle is damaged. This is known as **heart attack** or **myocardial infarction**.

- **Angina** Angina attacks occur when an individual has narrowed arteries. During activity the heart rate increases and muscle cells demand more oxygen. The narrowed arteries cannot supply enough blood to keep up with this demand and this triggers the pain of an angina attack which forces the person to rest. In severe cases, even everyday activities like climbing stairs can trigger an attack. Where symptoms are predictable and the individual is aware of what activities may bring on angina, this is known as 'stable angina'. Where symptoms come on at rest or seem unrelated to activity, and are getting worse over time, this is known as 'unstable angina'.

- **Peripheral vascular disease (PVD)**  
The same atherosclerotic process that causes coronary artery disease can also narrow peripheral arteries causing peripheral vascular disease. Peripheral vascular disease (PVD) is also known as peripheral arterial disease or PAD, and frequently involves more than one artery. The arteries that carry blood to the legs are commonly affected and this may result in discomfort in the legs when walking, but arteries that supply the arms, kidneys

and neck can also be affected. As with coronary artery disease, the atheroma may become unstable which can result in a clot that completely blocks the artery. This can happen very suddenly and requires urgent treatment. Some patients can have both coronary artery disease and PVD.

## Evidence

**What do coronary arteries do and what happens when they become diseased?**

## **Coronary angioplasty, stents and coronary artery by-pass graft (CABG)**

Coronary angioplasty is a procedure to open up narrowed or blocked coronary arteries. It is usually performed under local anaesthetic and a tube (catheter) is inserted via an artery in the wrist or groin and pushed up to the narrowed area of the coronary artery. A small balloon at the end of the catheter is then inflated to widen the narrowed area. Often, the procedure is combined with inserting a small metal mesh tube (a stent) so that when the balloon is deflated and the catheter removed, the stent helps to keep the artery open. This procedure is known as percutaneous coronary intervention (PCI).

Coronary artery by-pass grafting (CABG) is a surgical procedure for coronary artery disease. During CABG, a surgeon harvests a segment of healthy blood vessel (either an artery or a vein) from another part of the body for example, the leg, and uses it to create a detour or by-pass around the blocked portion of coronary artery.

Depending on how many arteries are blocked, a patient may need one, two, three or more by-passes.

## **3.10 Heart failure**

Heart failure is a condition where the heart isn't pumping blood as well as it should. It can develop for a number of reasons including following a heart attack, due to heart muscle disease (cardiomyopathy) or as a result of high blood pressure. Treatments for heart failure can include medication, lifestyle changes, having a pacemaker or other internal device fitted, and sometimes heart surgery.

## **3.11 Cardiovascular rehabilitation and physiotherapy**

Following a heart attack or heart surgery, many patients are referred to their local cardiovascular rehabilitation service. Cardiovascular rehabilitation, sometimes called 'cardiac rehabilitation' or 'cardiac rehab', is an individualised exercise, information and support programme delivered by a range of healthcare professionals including physiotherapists and other exercise professionals. It can often be accessed in a variety of ways such as attending in person or joining remotely from home using video calls, websites, mobile apps or telephone support. Dietary and lifestyle advice is provided, along with emotional support and a review of medical risk factors such as blood pressure and blood lipid levels,

to aid recovery and help patients improve the health of their heart in the long term. In many areas, cardiovascular rehabilitation is also offered to people living with other heart conditions, such as heart failure, or following other cardiac procedures and surgeries.

Cardiovascular rehabilitation programmes may lead to an improvement in exercise tolerance, improvement in symptoms of angina pectoris, improvement in blood lipid levels, improvement in psychosocial well-being, improvement in stress reduction and decreased morbidity.

### **Acknowledgements** NHS Tayside

#### **Evidence**

**What is the purpose of cardiovascular rehabilitation?**

**Find out where and when it is carried out in your organisation**

## 3.12 The cardiovascular system workbook completion

Your supervising physiotherapist will sign your portfolio to indicate that you have completed this workbook successfully.

Objective	Physiotherapist's Signature	Date
Name the main blood vessels and what they do		
Describe the structure and function of the heart		
Describe the components of blood and their function		
Describe the function of the lymphatic system		
Explain what is meant by blood pressure and describe normal values		
Explain the function of the coronary arteries and briefly describe the effects of coronary artery disease		
Describe the purpose and the benefits of cardiovascular rehabilitation		

Support worker (name)	
Support worker's signature	
Physiotherapist (name)	
Physiotherapist's signature	
Date	

## 3.13 The cardiovascular system reflection

This form should be placed in the appropriate section of your portfolio.

**What did you learn from this module?**

**How has this influenced your work?**

**Date module completed**

# Notes

# Notes

# Notes



Chartered Society  
of Physiotherapy

3rd Floor South  
Chancery Exchange  
10 Furnival Street  
London EC4A 1AB

**[www.csp.org.uk](http://www.csp.org.uk)**

Tel: **+44 (0)20 7306 6666**

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