

# WJEC (Wales) Biology GCSE

## Topic 1.4: Circulatory System Notes



## The circulatory system

The **circulatory system** is a **network** of **organs** and **vessels** which enables the **flow of blood** and **transport** of oxygen, carbon dioxide, nutrients and other molecules around the body.

### Blood

Blood is a body fluid which serves as a **transport medium** for nutrients and molecules around the body. It has **four** main components:

Component	Function
Red blood cells	Transport <b>oxygen</b> from the <b>lungs</b> to <b>tissues</b> : <ul style="list-style-type: none"> <li>• At the lungs haemoglobin in RBCs binds reversibly with oxygen to form oxyhaemoglobin</li> <li>• At the tissues oxyhaemoglobin breaks down to form haemoglobin and oxygen which diffuses into cells</li> </ul> Transport <b>carbon dioxide</b> from <b>tissues</b> to the <b>lungs</b>
White blood cells	Provide <b>immunological protection</b> : <ul style="list-style-type: none"> <li>• <b>Phagocytes</b> engulf and <b>destroy</b> pathogens</li> <li>• <b>Lymphocytes</b> produce <b>antibodies</b></li> </ul>
Plasma	<b>Pale-yellow liquid</b> portion of the blood that <b>transports</b> proteins, nutrients, waste products, hormones, antibodies, etc.
Platelets	Role in <b>blood clotting</b>

Red blood cells are adapted to their function:

- **Biconcave disk** gives a **large surface-area-to-volume ratio**, increasing diffusion rate.
- **Small and flexible** so they can **squeeze** through **capillaries**.
- **No nucleus** ∴ **more space** for **haemoglobin** molecules, increasing **oxygen-carrying capacity** of the cell.

Phagocytes (type of white blood cell) are adapted to their function:

- Can **change shape** to **engulf** **foreign material**.
- **Flexible membrane** ∴ can **squeeze** through **pores** in **capillary walls** and enter tissue fluid.
- Contain **enzymes** that **digest** **pathogens**.



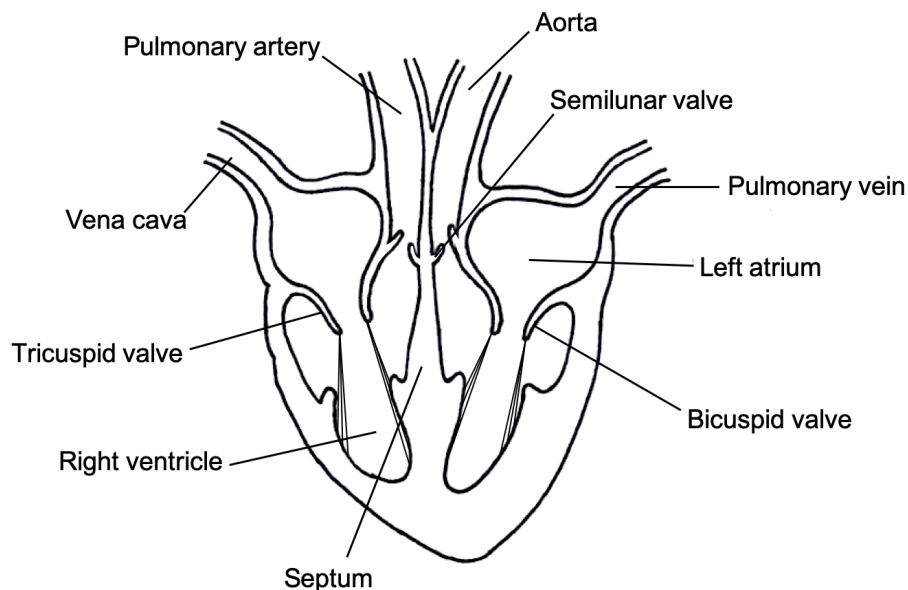
## Double circulatory system

Mammals have a **double circulatory system** where blood flows through the heart in two circuits: **pulmonary** circuit and **systemic** circuit.

Pulmonary circuit	Systemic circuit
Involves <b>right</b> side of heart	Involves <b>left</b> side of heart
<b>Deoxygenated</b> blood transported to <b>lungs</b>	<b>Oxygenated</b> blood pumped to <b>tissues</b> and <b>organs</b> around body
Gaseous exchange occurs between <b>alveoli</b> and <b>capillaries</b>	Exchange of materials occurs at <b>tissues</b>
<b>Oxygenated</b> blood returns to <b>left</b> side of heart	<b>Deoxygenated</b> blood returns to <b>right</b> side of heart

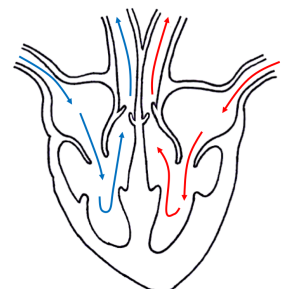
## Structure of the heart

The mammalian heart is a **muscular pump** that pushes blood around the body. It consists of **four chambers** (left atrium, left ventricle, right atrium and right ventricle) and associated **blood vessels**. The left and right sides of the heart are separated by a muscular wall, the **septum**.



The **coronary artery** supplies heart muscle with oxygen and nutrients.

**Blood flow:** Pulmonary vein → Left atrium → Left ventricle → Aorta → Body  
 → Vena cava → Right atrium → Right ventricle → Pulmonary artery → Lungs



The **wall** of the **left ventricle** is **thicker** than that of the **right ventricle**, as it must pump blood a **further distance** at a **higher pressure**. The walls of the ventricles are thicker than the atrial walls.

**Valves prevent backflow** of blood. They ensure that blood flow occurs in **one direction** only:

Valve		Location	Function
Atrioventricular	Bicuspid	Between left atrium and left ventricle	Stop blood flowing backwards from the ventricles into the atria
	Tricuspid	Between right atrium and right ventricle	
Semilunar		Between ventricles and arteries	Ensure that after leaving the heart, blood is not drawn back into the ventricles

## Blood vessels

There are **three** types of blood vessel in the body: **arteries**, **veins** and **capillaries**.

- **Arteries** carry blood **away** from the heart under **high** pressure
- **Veins** carry blood **towards** the heart under **low** pressure
- **Capillaries** enable the **exchange of materials** at tissues

Normally, **deoxygenated** blood travels in **veins** towards the heart and **oxygenated** blood travels in **arteries** away from the heart. The **only** exceptions to this are the **pulmonary artery**, which carries deoxygenated blood from the heart to the lungs, and the **pulmonary vein** which carries oxygenated blood from the lungs to the heart.

Each blood vessel is adapted to its function:

Vessel	Structure
Artery	<ul style="list-style-type: none"> <li>• <b>Narrow lumen</b> maintains high pressure</li> <li>• <b>Thick wall</b> to withstand high pressure</li> <li>• <b>Thick layer of smooth muscle</b> provides strength</li> <li>• <b>Thick layer of elastic fibres</b> allow <b>stretch</b> and <b>recoil</b></li> <li>• <b>Smooth inner lining</b> to reduce friction</li> <li>• No valves</li> </ul>
Vein	<ul style="list-style-type: none"> <li>• <b>Large lumen</b> eases blood flow</li> <li>• <b>Thin wall</b> allows muscles to easily compress the vein aiding blood flow</li> <li>• <b>Thin layer of smooth muscle and elastic fibres</b></li> <li>• <b>Valves</b> prevent backflow of blood</li> </ul>



Capillary	<ul style="list-style-type: none"><li>• Form <b>large network</b> ∴ greater surface area for diffusion</li><li>• Walls <b>one cell thick</b> giving a <b>short diffusion distance</b></li><li>• Walls <b>permeable</b> allowing the exchange of substances</li><li>• <b>Narrow lumen</b> decreases diffusion distance</li></ul>
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## Cardiovascular disease (CVD)

Cardiovascular disease is a group of diseases affecting the heart or blood vessels.

A build up of fatty deposits on the walls of the arteries forms **atheromas** which **reduce blood flow** to muscle tissue. **Blood clots** may form, blocking the arteries and stopping blood flow completely. This can lead to a **heart attack** or **stroke**.

### Risk factors for CVD

A **risk factor** is a variable associated with a **greater chance** of developing a disease or infection. Risk factors for cardiovascular disease include:

- **High blood pressure** - damages blood vessel walls and promotes the deposition of fatty substances, increasing the risk of atherosclerosis
- **High blood cholesterol** - cholesterol deposited on the walls of blood vessels increasing the risk of atherosclerosis
- **Smoking** - carbon monoxide reduces the oxygen-carrying capacity of blood ∴ heart must work harder to deliver the required volume of oxygen to tissues
- **Obesity** - fat builds up around the heart muscle ∴ heart must work harder to pump blood around the body
- **Lack of exercise** - exercise improves the efficiency of the heart and reduces obesity
- **Family history of heart disease** - genetic predisposition
- **Poor Diet** - high in fat and salt

### Treating CVD

There are three methods of treating cardiovascular disease:

- **Improving diet and lifestyle**
- **Medication**
- **Angioplasty**



Treatment	Description	Advantages	Disadvantages
Improving diet and lifestyle	<p>Diet and lifestyle changes can be made to reduce the risk of CVD or enhance the <b>efficiency</b> of other treatment methods:</p> <ul style="list-style-type: none"> <li>• Regular exercise</li> <li>• Reduce intake of saturated fat</li> <li>• Maintenance of healthy weight</li> <li>• Diet low in salt</li> <li>• Reduce stress</li> <li>• Stop smoking</li> <li>• Stop drinking alcohol</li> </ul>	Avoids risk of surgery and side effects of drugs.	Generally <b>less effective</b> than other methods Relies on the patient's perseverance to make the changes.
Statins	A group of drugs that <b>lower blood cholesterol</b> levels.	Convenient - taken orally	<p><b>Side effects</b> - liver damage, kidney failure, memory problems.</p> <p>Do not directly treat CVD but reduce the risk factor of high blood cholesterol.</p>
Angioplasty	A small balloon is used to inflate an artery and a hollow tube (known as a <b>stent</b> ) is inserted into the lumen. The stent expands, holding the artery open.	More permanent treatment	<p>Insertion requires <b>surgery</b>.</p> <p>Stents cause the growth of <b>scar tissue</b> in the arteries over time, further narrowing the lumen.</p> <p>Blood clots may stick to stents.</p>

