

The heart and circulation

Revision notes · How the structure of the heart, valves and blood vessels allows blood to circulate, and how to calculate cardiac output.

For Edexcel GCSE Biology 1BI0 and Combined Science 1SC0. **Triple only** is not in Combined Science. **Higher tier** is only on the Higher paper.

The heart and circulation Spec 8.8, 8.12

The heart and circulatory system Spec 8.8

Humans have a **double circulatory system**. In one circuit the blood goes from the heart to the lungs and back. In the other the blood goes from the heart around the body and back. Blood passes through the heart twice on each complete circuit of the body.

1. Deoxygenated blood from the body enters the right atrium through the vena cava.
2. The right atrium contracts and pushes blood into the right ventricle.
3. The right ventricle contracts and pumps blood to the lungs through the pulmonary artery.
4. Oxygenated blood returns from the lungs through the pulmonary vein into the left atrium.
5. The left atrium contracts and pushes blood into the left ventricle.
6. The left ventricle contracts and pumps blood around the body through the aorta.

Major blood vessels of the heart		
Blood vessel	Carries blood	Between
Vena cava	Deoxygenated	Body → right atrium
Pulmonary artery	Deoxygenated	Right ventricle → lungs
Pulmonary vein	Oxygenated	Lungs → left atrium
Aorta	Oxygenated	Left ventricle → body

Valves

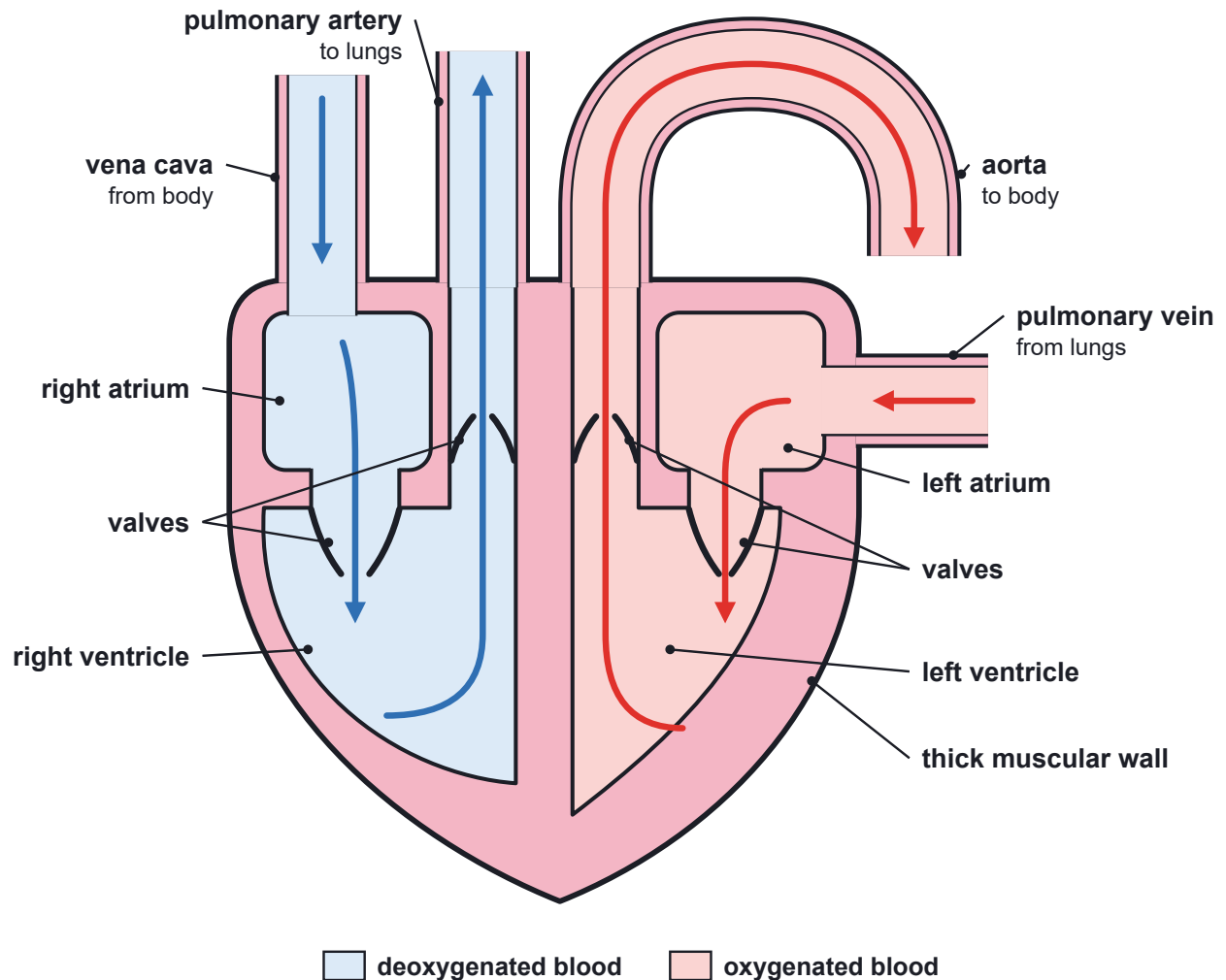
The heart has **valves** between the atria and ventricles, and where the pulmonary artery and aorta leave the ventricles. They open to let blood through in one direction and close to **prevent backflow**.

Thickness of the chamber walls

- The ventricles have thicker, more muscular walls than the atria, because they pump blood out of the heart and further.
- The **left ventricle** has a thicker wall than the right ventricle. It pumps blood around the whole body, which needs a higher pressure. The right ventricle pumps blood only to the lungs, which are close by.

The blood pressure falls as blood passes through the capillaries in the lungs. Returning the blood to the heart before it goes to the body lets the left ventricle increase the pressure again, so blood can reach the rest of the body quickly.

Common mistake: The diagram of the heart is drawn as if you are facing the person, so the left side of the heart is on the right of the page. Check which side is which before you answer.



Blood flows **vena cava** → **right atrium** → **right ventricle** → **pulmonary artery**, then **pulmonary vein** → **left atrium** → **left ventricle** → **aorta**. The left side of the heart is on the **right of the page**.

Heart rate, stroke volume and cardiac output Spec 8.12

Heart rate	The number of times the heart beats per minute (bpm).
Stroke volume	The volume of blood pumped out of the heart in each beat, in cm ³ .
Cardiac output	The volume of blood pumped out of the heart per minute, in cm ³ per minute.

$$\text{cardiac output} = \text{stroke volume} \times \text{heart rate}$$

Calculating cardiac output

A person has a resting heart rate of 70 beats per minute and a stroke volume of 75 cm³. Calculate the cardiac output.

- cardiac output = stroke volume × heart rate
- cardiac output = 75 × 70 = 5250

Answer: 5250 cm³ per minute

You may be asked to rearrange the equation. Stroke volume = cardiac output ÷ heart rate. Heart rate = cardiac output ÷ stroke volume.

You can measure heart rate by taking a pulse for a set time, for example counting beats in 30 seconds and doubling. A suggested practical is to investigate the short-term effect of exercise on heart rate and breathing rate, which both increase to supply more oxygen to the working muscles.

Maths skill: Check the units. If a question gives heart rate in beats per minute and stroke volume in cm^3 , the answer is in cm^3 per minute. Give the unit in your answer.

Quick check

1. Which vessel carries oxygenated blood from the lungs to the heart?
2. Why is the wall of the left ventricle thicker than the wall of the right ventricle?
3. What is the job of the valves in the heart?
4. State the equation for cardiac output.

Quick check answers

The heart and circulation

- 1 . The pulmonary vein.
- 2 . It pumps blood around the whole body, which needs a higher pressure than pumping blood to the lungs.
- 3 . To prevent backflow and keep blood flowing in one direction.
- 4 . Cardiac output = stroke volume $\times$ heart rate.