

Transport in animals revision notes

Transport in animals looks at how blood is pumped around the body and what it carries. You study the heart, the blood vessels and the components of blood, how exercise affects the heart, and the causes of coronary heart disease.

For Cambridge IGCSE Combined Science 0653, **Supplement** is Extended content, only examined on Papers 2 and 4.

1 Circulatory systems Spec B9.1

The circulatory system Spec B9.1.1

The **circulatory system** is a system of blood vessels with a pump and valves to ensure **one-way flow of blood**. The pump is the heart. The vessels are arteries, veins and capillaries. Valves stop blood flowing backwards.

Quick check

1. What is the circulatory system?
2. What is the pump of the circulatory system?
3. What is the job of the valves in the circulatory system?

2

The heart

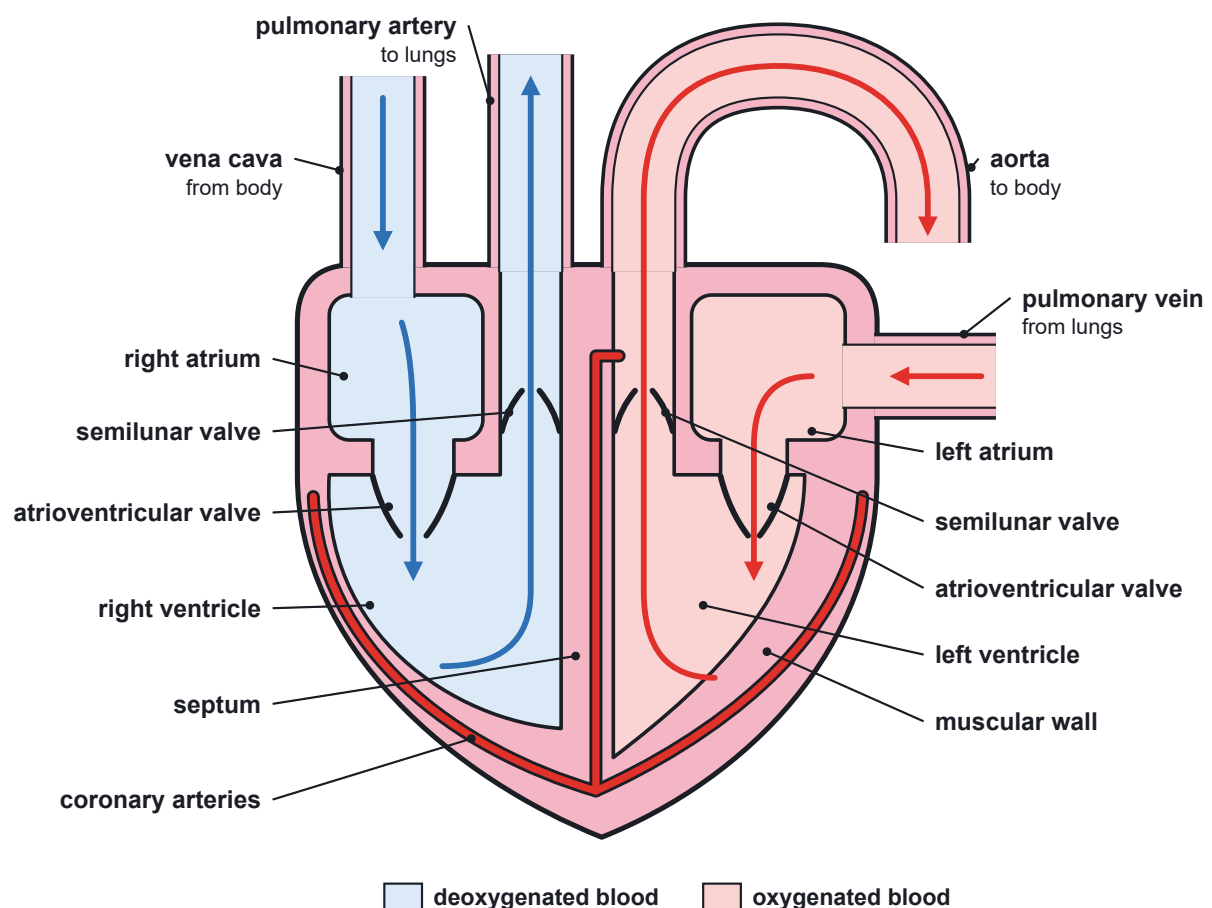
Spec B9.2

Structure of the heart

Spec B9.2.1, B9.2.2

The mammalian heart is a pump made of cardiac muscle. You need to identify these structures in diagrams and images.

Structures of the heart	
Structure	What it is or does
Muscular wall	Contracts to squeeze blood out of the chambers
Right atrium and left atrium	Upper chambers that receive blood from veins
Right ventricle and left ventricle	Lower chambers that pump blood out into arteries
Septum	Wall of muscle between the left and right sides of the heart
One-way valves	Stop blood flowing backwards
Coronary arteries	Run over the surface of the heart and supply the heart muscle with oxygenated blood (oxygen and glucose)



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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.

Blood is pumped **away from the heart in arteries** and **returns to the heart in veins**.

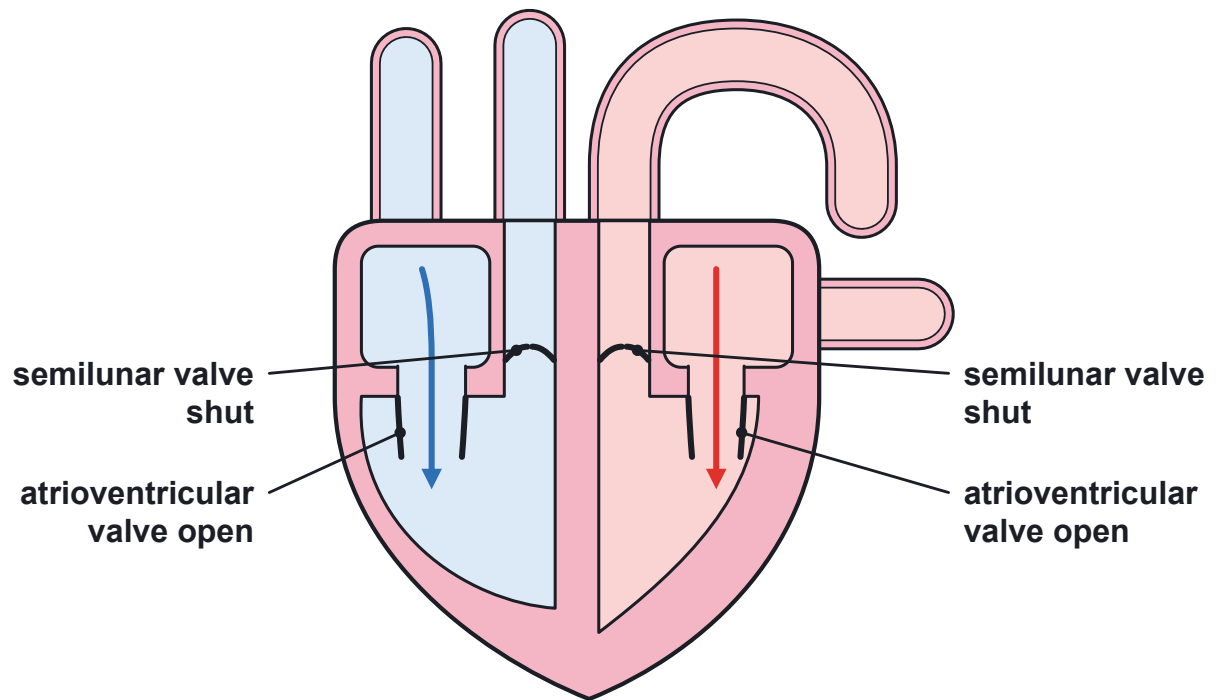
Common mistake: The heart is drawn as if you are facing the person. The left side of the heart is on the right of the page. The coronary arteries supply the heart itself, not the lungs.

How the heart pumps blood Spec B9.2.5 Supplement

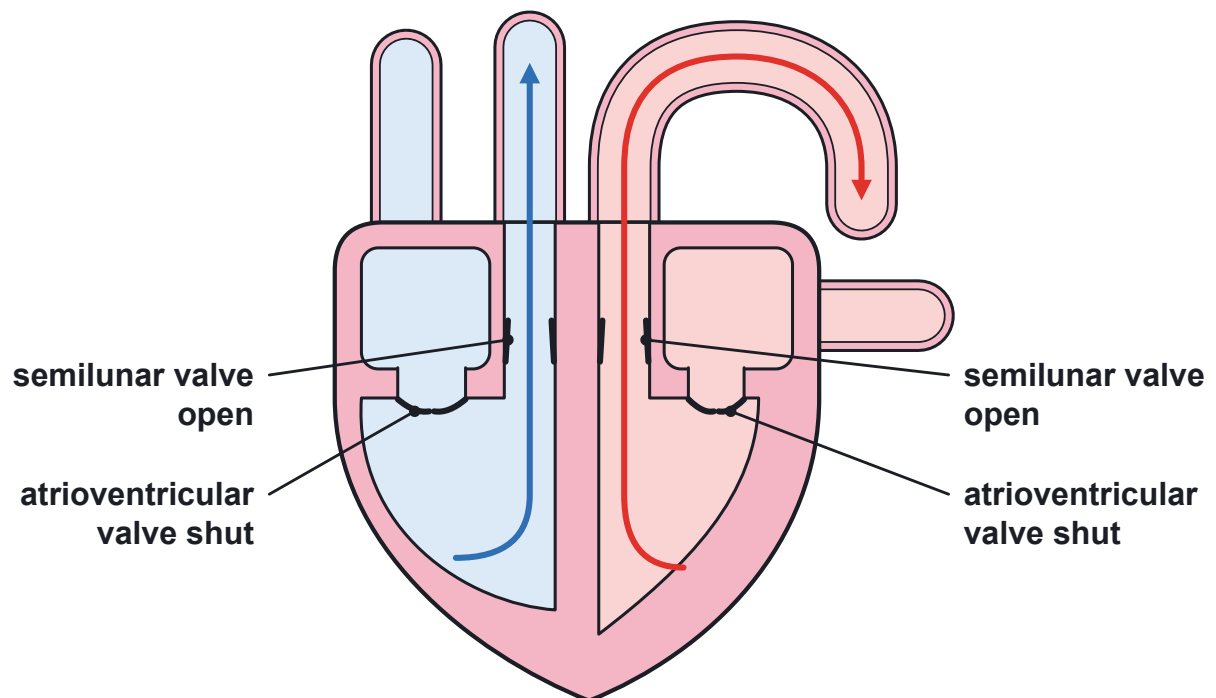
The pumping action

- 1 . Blood flows into the atria from the veins. The atria contract and push blood through the open **atrioventricular valves** into the ventricles.
- 2 . The ventricles contract. Pressure rises, the atrioventricular valves shut (stopping blood flowing back into the atria) and the **semilunar valves** open.
- 3 . Blood is forced out of the ventricles into the aorta and pulmonary artery.
- 4 . The ventricles relax. The semilunar valves shut, which stops blood flowing back into the ventricles. The atria fill again.

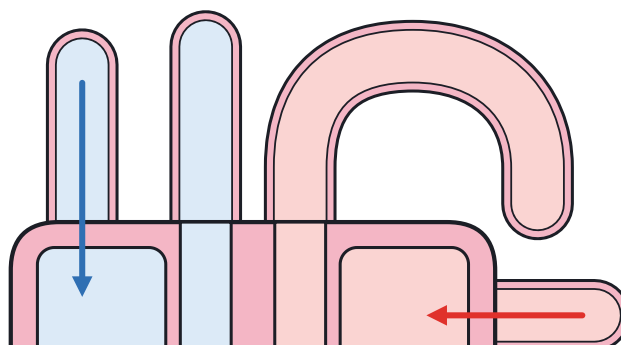
1 The atria contract

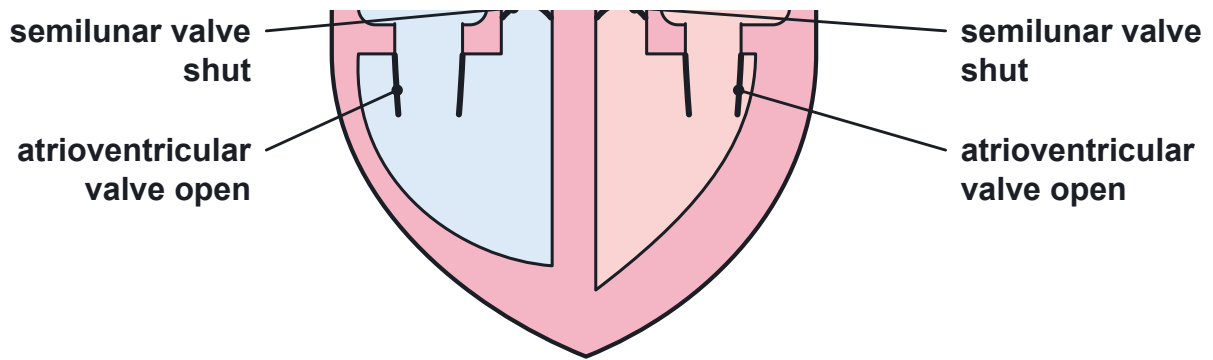


2 The ventricles contract



3 The heart relaxes and the atria fill





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The valves open and shut because of **blood pressure**, so blood flows only one way.

Exam tip: The valves open and shut because of the pressure of the blood, not because the valves can contract. Say which valve and which way the blood is pushed.

Monitoring the heart and the effect of exercise Spec B9.2.3, B9.2.4, B9.2.6

The activity of the heart may be monitored in three ways.

- An **ECG** (electrocardiogram), which records the electrical activity of the heart.
- **Pulse rate**, felt at the wrist or neck, which is the number of beats per minute.
- **Listening to the sounds of the valves closing**, using a stethoscope.

Practical skill: Investigating the effect of physical activity on heart rate. Independent variable: the activity (for example, minutes of step-ups or jogging on the spot). Dependent variable: heart rate in beats per minute. Control: the same person, same time of day, same length of rest. Repeat and calculate a mean. Safety: stop if you feel dizzy or unwell, and do not take part if you have a heart or breathing condition.

1. Sit still for several minutes, then measure the resting pulse rate by counting beats for 15 seconds and multiplying by 4.
2. Do a set exercise for a fixed time, for example 2 minutes of step-ups.
3. Measure the pulse rate immediately after exercise.
4. Keep measuring every minute until the pulse returns to the resting rate. Record the recovery time.
5. Repeat with a different level of exercise and compare.

Calculating heart rate from a pulse count

A student counts 19 beats in 15 seconds. Calculate the heart rate in beats per minute.

1. 15 seconds is one quarter of a minute
2. heart rate = 19×4

Answer: 76 beats per minute

Typical results: heart rate rises during exercise and returns to the resting rate during recovery. The harder the exercise, the higher the rate and the longer the recovery.

Supplement

Explaining the effect of exercise

Supplement

During physical activity the muscles respire faster, so they need more oxygen and glucose and produce more carbon dioxide. Heart rate increases so that blood flows faster and:

Supplement

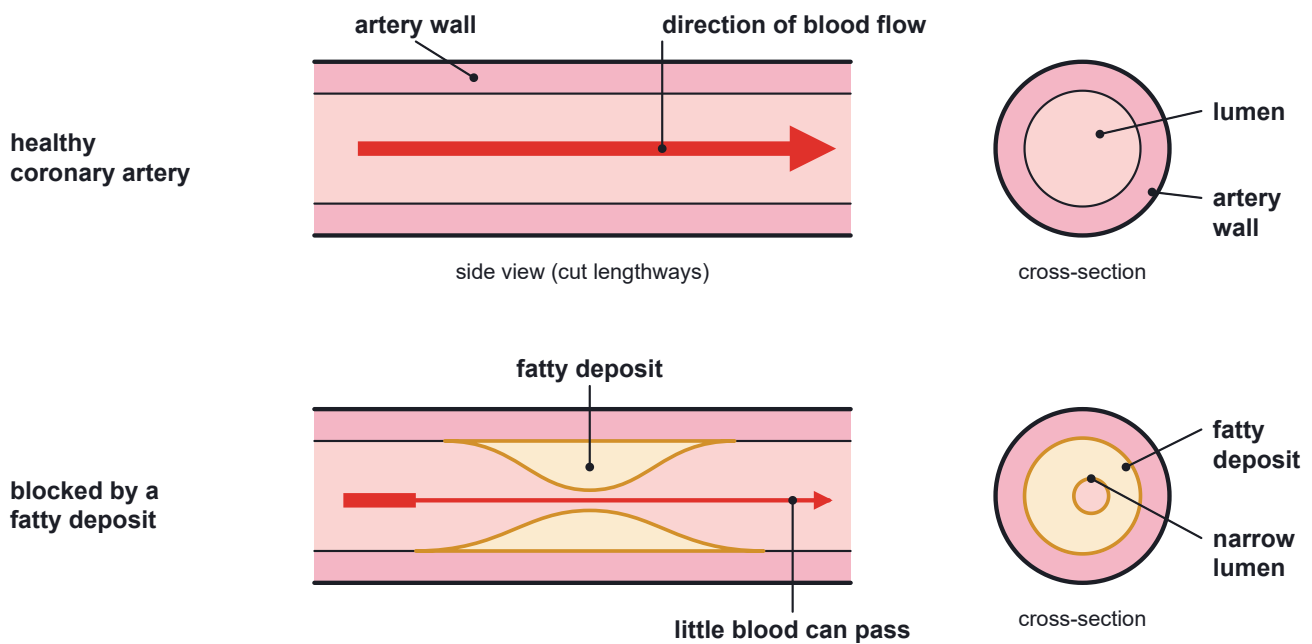
- more oxygen and glucose are delivered to the muscles for aerobic respiration
- carbon dioxide is removed more quickly, and lactic acid is carried away from the muscles if anaerobic respiration has happened

Supplement

Common mistake: Heart rate does not rise to 'give the muscles energy'. It rises to deliver oxygen and glucose faster and to remove carbon dioxide.

Coronary heart disease Spec B9.2.7, B9.2.8 Supplement

In **coronary heart disease** (CHD) the **coronary arteries are blocked** by fatty deposits. Less blood reaches the heart muscle, so it receives less oxygen and glucose. If an artery is completely blocked, part of the heart muscle cannot get enough oxygen to respire, and a heart attack results.



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A **fatty deposit** narrows the lumen, so less blood reaches the heart muscle.

Risk factors

- Diet, especially one high in saturated fat
- Lack of exercise
- Stress
- Smoking
- Genetic predisposition (family history)

- Age (risk increases with age)
- Sex (men are more at risk than women of the same age)

The roles of diet and exercise

Reducing the risk of CHD	
Factor	How it reduces the risk
Diet	Eating less saturated fat reduces the fatty deposits in the arteries. Eating less salt and more fruit, vegetables and fibre helps keep the arteries and blood pressure healthy
Exercise	Regular exercise strengthens the heart muscle, helps to control body mass and lowers blood pressure, so the risk of blockage is lower

Exam tip: 'Discuss' means give both sides. For diet and exercise, say what each does, and also that other risk factors such as age and genes cannot be changed.

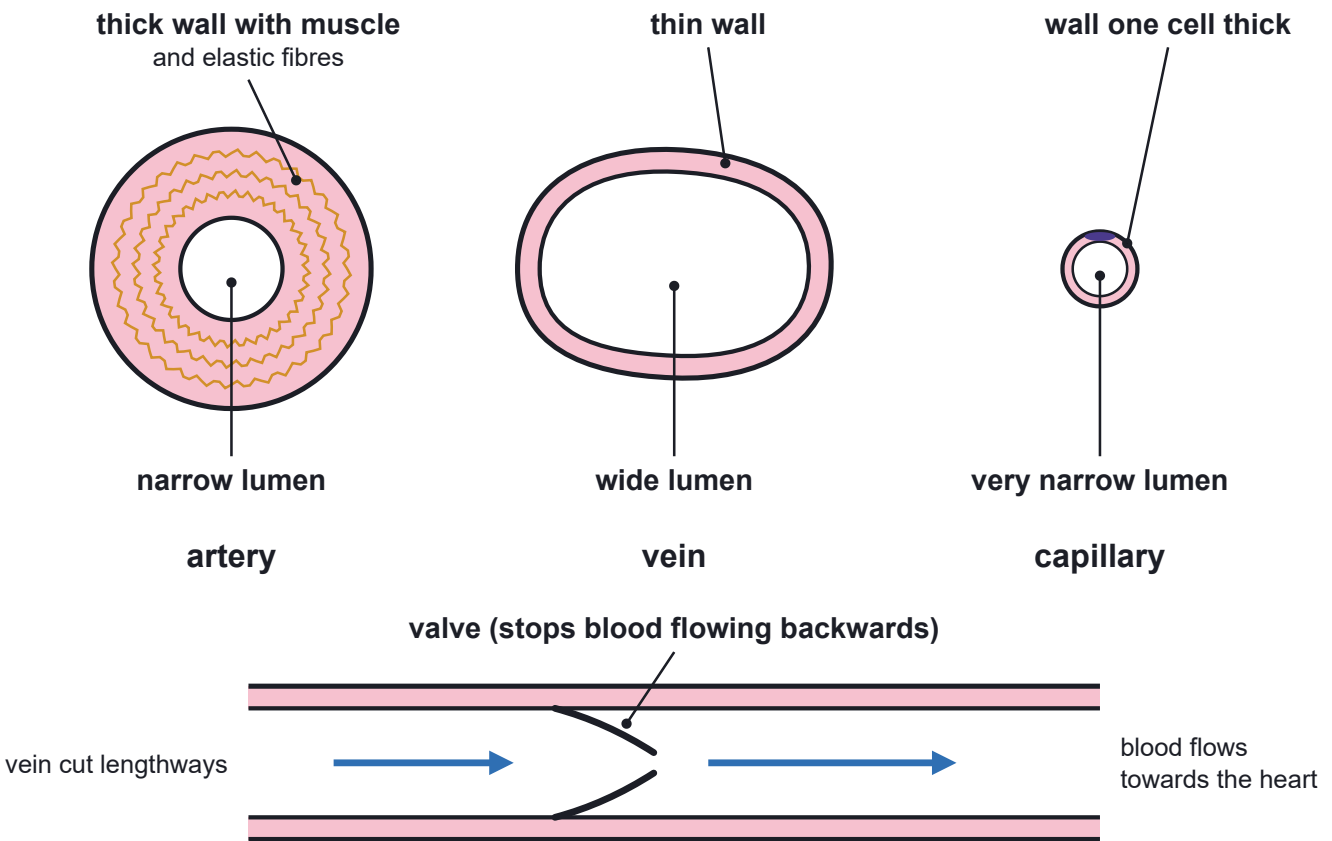
Quick check

1. Name the vessels that supply the heart muscle with blood.
2. State three ways of monitoring the activity of the heart.
3. **Supplement** State two risk factors for coronary heart disease.

3 Blood vessels Spec B9.3

Arteries, veins and capillaries Spec B9.3.1, B9.3.2

Structure of blood vessels			
Vessel	Wall	Lumen	Valves
Artery	Thick	Narrow	No
Vein	Thin	Wide	Yes
Capillary	One cell thick	Very narrow	No



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Arteries have thick walls, veins have a wide lumen and valves, capillaries have walls one cell thick. (The capillary is drawn much larger than its real size.)

Supplement

Structure related to pressure

Supplement

- Arteries** carry blood away from the heart at high pressure. Their thick walls, containing muscle and elastic fibres, withstand the pressure and stretch and recoil with each beat. The narrow lumen helps to maintain the pressure.
- Veins** carry blood back to the heart at low pressure. They need only thin walls, and the wide lumen gives little resistance to flow. Valves stop the blood flowing backwards.

Supplement

Exam tip: Do not say that veins have 'no muscle'. Say their walls are thinner because the blood is at lower pressure.

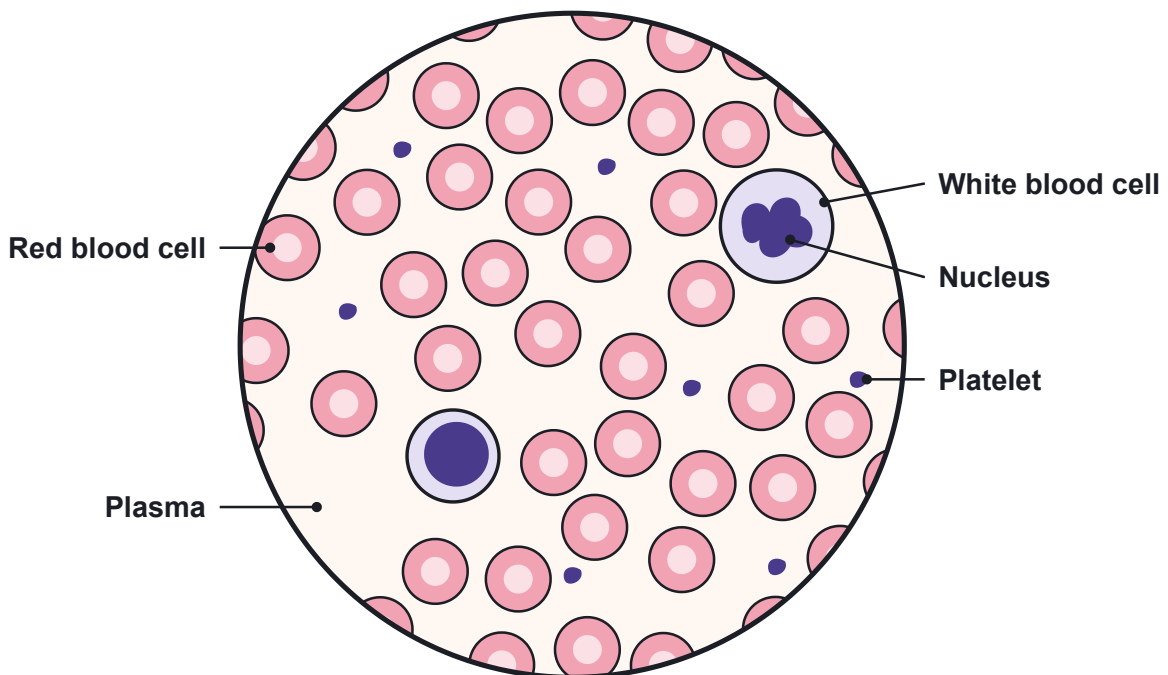
Quick check

1. Which blood vessels have valves?
2. **Supplement** Why do arteries have thick walls?

4 Blood Spec B9.4

Components of blood Spec B9.4.1, B9.4.2, B9.4.3

Blood is made of red blood cells, white blood cells, platelets and plasma. Plasma is the liquid part.



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Red blood cells are the most numerous. White blood cells have a **nucleus**. Platelets are tiny fragments.

- Red blood cells are small, round and pale in the middle, with **no nucleus**.
- White blood cells are larger and have a **nucleus**, usually stained dark.
- Platelets are tiny fragments of cells.

Functions of the components of blood

Component	Function
Red blood cells	Transport oxygen. They contain the red pigment haemoglobin , which combines with oxygen
White blood cells	Defend against pathogens by phagocytosis and antibody production
Platelets	Help blood to clot
Plasma	Transports blood cells, ions, nutrients, urea, hormones and carbon dioxide

Exam tip: Name the pigment. 'Red blood cells carry oxygen' is not enough: say the oxygen is carried by haemoglobin. Clotting details are not required for platelets.

White blood cells and blood clotting Spec B9.4.4 Supplement

Roles of blood clotting

When the skin is cut, blood clots to **prevent blood loss** and to **prevent the entry of pathogens** into the body. The clot dries to form a scab.

Quick check

- 1 . List the four components of blood.
- 2 . What is the function of haemoglobin?
- 3 . **Supplement** State two roles of blood clotting.

Quick check answers

Circulatory systems

1. A system of blood vessels with a pump and valves to ensure one-way flow of blood.
2. The heart.
3. To stop blood flowing backwards, so it flows one way only.

The heart

1. The coronary arteries.
2. ECG, pulse rate, listening to the sounds of the valves closing.
3. Any two of: diet, lack of exercise, stress, smoking, genetic predisposition, age, sex.

Blood vessels

1. Veins.
2. They carry blood at high pressure, so the walls must withstand it.

Blood

1. Red blood cells, white blood cells, platelets and plasma.
2. To transport oxygen in the red blood cells.
3. Prevents blood loss and prevents entry of pathogens.