

The Heart and Blood Vessels

Mark Scheme



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1. The following questions look at various aspects of the circulation system. Answer each part by circling the correct answer from the options given.

- a) The diagram below shows a section through a human heart.
Which two chambers will contract at the same time? Circle the letter of the correct answer.

A – is the only correct answer.	1 mark
	Total: 1 mark

- b) The figure below shows cross-sections through three types of blood vessel, not to the same scale.
Which cross-section shows a vein? Circle the letter of the correct answer.

Z – is the only correct answer.	1 mark
	Total: 1 mark

- c) Which blood component is responsible for clotting?
Circle the letter of the correct answer.

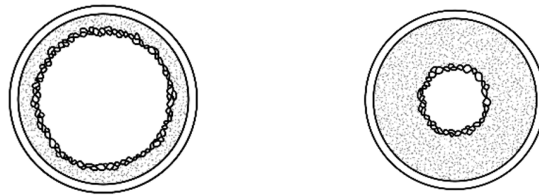
C – is the only correct answer.	1 mark
	Total: 1 mark

- d) The diagram below shows a section through a human heart.
In which chamber would the pace maker be found? Circle the letter of the correct answer.

B – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 4 marks)

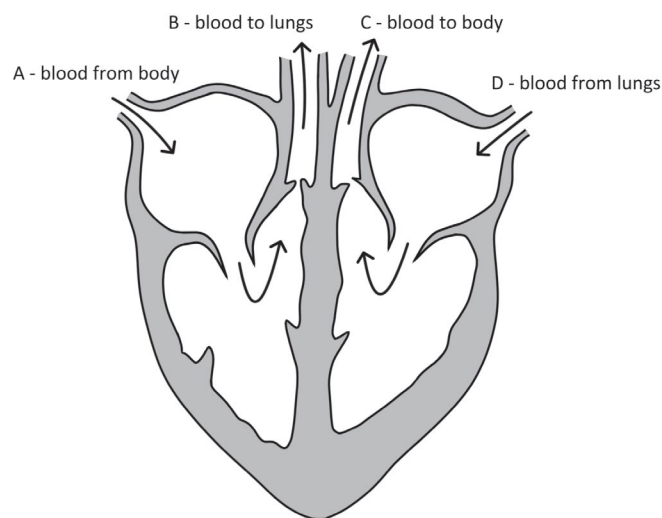
2. The figure below shows a section through a vein and artery.



a) Describe **three** structural differences between a vein and an artery.

A description to include any <u>three</u> of the following:	
Artery has thicker wall / vein has thinner wall.	1 mark
Allow: muscle/elastic layer is thicker in artery / thinner in vein.	
Artery has narrower lumen / vein has wider lumen.	1 mark
Allow: smaller hole/bore/central channel' for lumen.	
Artery has more / thicker muscle (tissue). Allow 'thicker muscular wall'.	1 mark
Artery has more / thicker elastic tissue / elastic fibres.	1 mark
Allow: more elastic wall / is more elastic.	
Vein has valves / artery does not have valves.	1 mark
Allow: valves are present in veins but absent in arteries.	
	Total: 3 marks

b) The figure below shows a section through a human heart.



Identify the blood vessels A, B, C and D from the figure of the heart above.

A = Vena cava	1 mark
B = Pulmonary artery	
C = Aorta	
D = Pulmonary vein	
	Total: 4 marks

c) Which **two** blood vessels in the figure above carry deoxygenated blood?

Vena cava	1 mark
Pulmonary artery	1 mark
	Total: 2 marks

(Total for Question 2 is 9 marks)

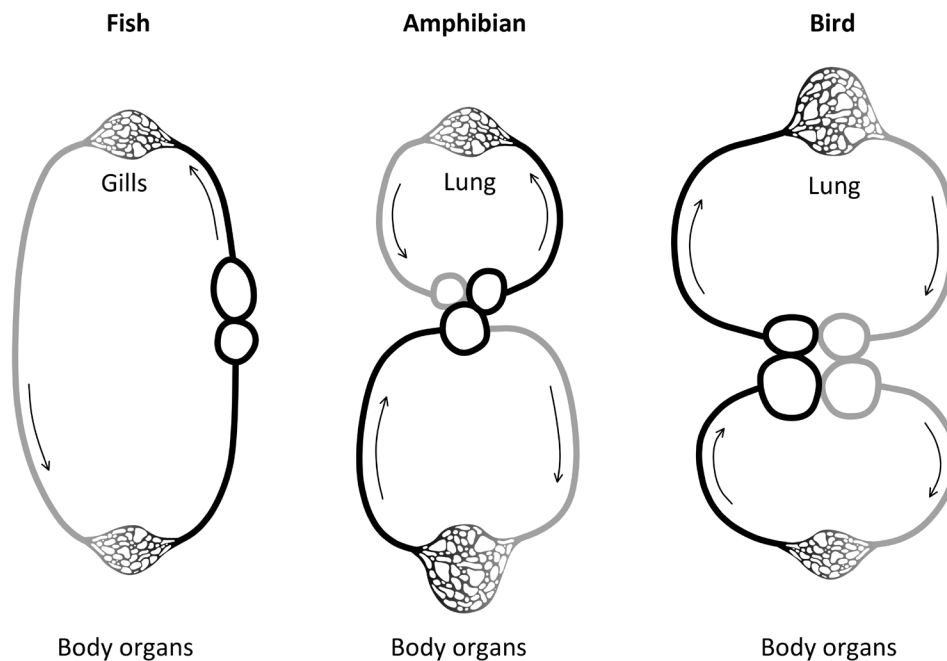
3. Describe the functions of each of the components of the blood.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Demonstrates basic knowledge. Identifies at least two components of blood and provides a limited or partially correct description of the function of at least one component.
Level 2	3 - 4	Describes the function(s) of at least three components of blood correctly . Some descriptions may lack detail or minor inaccuracies may be present.
Level 3	5 - 6	Describes the function(s) of all four major components of blood (plasma, red blood cells, white blood cells, platelets) accurately and in detail. Uses appropriate scientific terminology consistently and correctly.

Indicative content:	
Plasma: - Is the liquid part / matrix of the blood. - Transports substances / cells around the body. - Examples of transported substances: carbon dioxide (CO₂), urea, digested food / glucose / amino acids, hormones, antibodies, heat, water, proteins. (Credit specific examples) Red Blood Cells: - Transport oxygen. - From the lungs to the (respiring) tissues/cells. - Contain haemoglobin. - Haemoglobin binds with oxygen (to form oxyhaemoglobin). (Allow structural link: biconcave shape gives large surface area for oxygen exchange; no nucleus allows more space for haemoglobin). White Blood Cells: - Involved in defence against disease / pathogens / microorganisms / immune response. - Phagocytes: engulf / ingest / digest pathogens / microorganisms (phagocytosis). - Lymphocytes: produce antibodies. - Antibodies cause agglutination / clumping of pathogens OR mark pathogens for destruction (by phagocytes). - Lymphocytes: produce antitoxins. - Antitoxins neutralise toxins produced by pathogens. Platelets: (Small fragments of cells) involved in blood clotting. - Help to form a clot / scab. - Prevents further blood loss / haemorrhage. - Prevents entry of pathogens / microorganisms (at wound site).	
	Total: 6 marks

(Total for Question 3 is 6 marks)

4. Look at figure below, it shows the circulation systems in a fish, amphibian and bird.



a) Which circulatory system is most similar to humans and give a reason for your answer?

<u>Bird</u>	1 mark
Any two of the following reasons:	
It is a double circulatory system.	1 mark
Has a four-chambered heart / 4 chambers.	1 mark
Accept: has two ventricles and two atria	
Oxygenated and deoxygenated blood are kept separate / do not mix (in the heart)	1 mark
	Total: 3 marks

The figure below shows the estimated blood flow through different part of the body when someone is exercising and when they are resting

Body part	Estimated rate of blood flow in cm ³ per minute	
	Resting	Exercising
Digestive system	1000	3000
Brain	800	805
Heart muscle	480	2800
Other muscles	1500	18250
Lungs	1200	19500
Other organs	1180	1120

b) The volume of blood moving through the heart increases when the person exercises. Determine the percentage change in blood flow through the heart during the exercise.

$2800 - 480 = 2320$	1 mark
$(2320 \div 480) \times 100 = 483.3 \%$	1 mark
Allow answers in range 483 % to 483.3 % inclusive.	
	Total: 2 marks

- c) Explain why there is a change in the rate of blood flow through the digestive system during exercise.

An explanation to include any two of the following:	
Blood flow (to digestive system) decreases.	1 mark
More blood is diverted or redirected to muscles (or lungs / heart muscle).	1 mark
Muscles need more oxygen / glucose	1 mark
For increased <u>aerobic</u> / anaerobic respiration	1 mark
Allow "to release more energy / provide more ATP"	
To remove (more) carbon dioxide / lactic acid (from muscles).	1 mark
Allow "to remove waste products from muscles"	
	Total: 2 marks

- d) The stroke volume is the amount of blood leaving two chambers of the heart after each contraction.
From which chamber of the heart does this volume of oxygenated blood flow?

Left ventricle.	1 mark
	Total: 1 mark

- e) A person has a cardiac output of 6.2 litres per minute. Their heart rate is measured at 150 beats per minute. Determine the stroke volume, give your answer in millilitres.

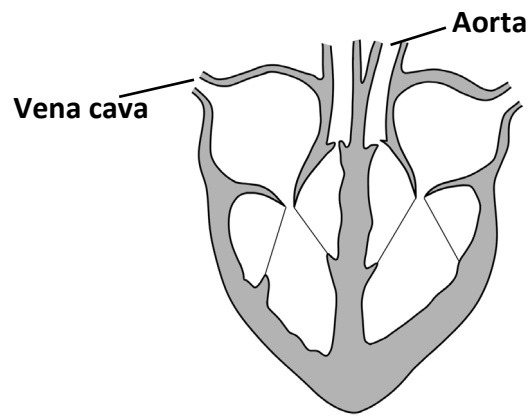
Step 1: Unit conversion. $6.2 \text{ (litres)} = 6200 \text{ (millilitres / ml)}$	1 mark
Step 2: Calculation. $6200 \div 150 = 41.3 \text{ ml}$	1 mark
Allow: 41.33 ml	
	Total: 2 marks

- f) Explain why the cardiac muscle wall of the left ventricle is significantly thicker than the cardiac muscle wall of the right ventricle.

An explanation to include any four of the following:	
Left ventricle pumps blood to the entire body / systemic circulation	1 mark
Right ventricle pumps blood only to the lungs / pulmonary circulation	1 mark
Blood pumped to the body is a greater distance than to the lungs	1 mark
Allow "Left ventricle has to pump blood further".	
Higher pressure / greater force is needed from the left ventricle.	1 mark
Allow "Left ventricle generates higher pressure".	
Blood pumped to the lungs is a shorter distance / lower pressure required (from right ventricle)	1 mark
Allow "Right ventricle generates lower pressure".	
Higher resistance (in systemic circuit / body compared to pulmonary circuit / lungs)	1 mark
(thicker muscle wall allows more forceful contraction / generates higher pressure.	1 mark
Allow "Thicker wall is stronger / has more muscle"	
	Total: 4 marks

(Total for Question 4 is 14 marks)

5. The figure below shows a section through a human heart.



a) Using your knowledge and the figure above explain the blood flow through heart from the Vena Cava to the Aorta. Your answer should include the valves that the blood moves through.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Identifies that blood enters the right side and leaves the left side. Correctly names at least two chambers OR identifies at least one valve correctly.
Level 2	3 - 4	Describes the main pathway of blood through the heart, usually including passage through the lungs. Correctly names at least three chambers in sequence and identifies at least one valve correctly positioned in the pathway.
Level 3	5 - 6	Describes the full pathway of blood clearly and logically from the Vena Cava to the Aorta, including passage through the lungs. Correctly names all four chambers in sequence and identifies at least three major valves (atrioventricular and/or semi-lunar) correctly positioned in the pathway.

Indicative content:	
- Deoxygenated blood enters the right atrium from the Vena Cava. - The right atrium contracts. - Blood passes through the tricuspid valve (allow right atrioventricular / AV valve). - Into the right ventricle. - The right ventricle contracts. - Blood passes through the pulmonary valve (allow semi-lunar valve). - Into the pulmonary artery. - Blood travels to the lungs (where it becomes oxygenated). - Oxygenated blood returns from the lungs via the pulmonary vein. - Into the left atrium. - The left atrium contracts. - Blood passes through the bicuspid / mitral valve (allow left atrioventricular / AV valve). - Into the left ventricle. - The left ventricle contracts. - Blood passes through the aortic valve (allow semi-lunar valve). - Into the Aorta (to be transported to the body).	
	Total: 6 marks

- b) During exercise, a runner has a cardiac output of 15 litres per minute. Their stroke volume is measured to be 150 ml per beat. Define the term cardiac output.

The volume / amount of blood pumped by the heart (OR a ventricle) per minute / in one minute / per unit time.	1 mark
	Total: 1 mark

- c) Calculate the runner's heart rate in beats per minute, bpm, during this period of exercise.

Step 1: Unit Conversion OR Formula Rearrangement.	1 mark
15 L = 15000 ml OR 150 ml = 0.15 L	
Step 2: Heart rate = cardiac output ÷ stroke volume	1 mark
Heart rate = 15 000 ÷ 150 Heart rate = 100	
	Total: 2 marks

- d) Explain how regular exercise can lead to a lower resting heart rate.

An explanation to include any two of the following:	
Regular exercise strengthens the heart muscle.	1 mark
Allow: heart muscle grows / gets bigger / becomes stronger"	
Therefore stroke volume increases / heart pumps more blood per beat.	1 mark
So, fewer beats per minute needed at rest to supply the same volume of blood / maintain cardiac output	1 mark
	Total: 2 marks

- e) Identify the blood vessels that supply the heart itself with oxygenated blood.

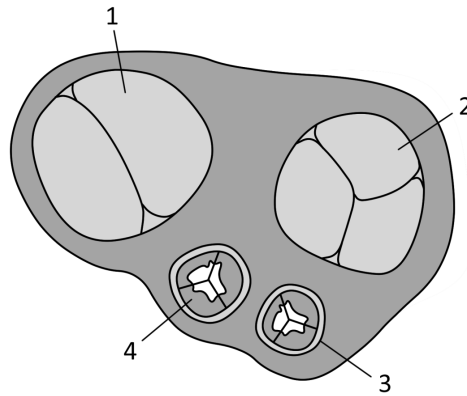
Coronary arteries.	1 mark
	Total: 1 mark

- f) Explain how a blockage in the blood vessels that supply the heart could lead to a heart attack.

An explanation to include any four of the following:	
Blood vessels are the coronary arteries.	1 mark
Coronary arteries supply blood to the heart muscle / cardiac muscle cells	1 mark
Blood supplies oxygen / glucose	1 mark
Blockage reduces / stops blood flow through coronary artery.	1 mark
Allow "Narrowing restricts blood flow"	
So, the heart muscle cells receive less / no oxygen / glucose.	1 mark
Allow "Lack of / shortage of oxygen / glucose".	
Heart muscle cells cannot respire aerobically as much / at all.	1 mark
Allow "Respiration rate decreases / stops"	
Heart muscle cells / tissue die / are damaged	1 mark
	Total: 4 marks

(Total for Question 5 is 16 marks)

6. The figure below shows an internal view of the human heart with the atria removed so valves can be seen.



- a) Which of the valves, labelled 1 to 4, is pushed open by oxygenated blood entering a ventricle?
Circle the letter of the correct answer.

A – is the only correct answer.	1 mark
	Total: 1 mark

- b) Valves are found in the heart and in veins.
What is the function of valves.

Accept any <u>two</u> of the following:	
To prevent the backflow of blood	1 mark
Ensuring blood flows in one direction / the correct direction.	1 mark
Valves open to allow blood to flow through.	1 mark
	Total: 2 marks

- c) Identify the valves that are found between the right atrium and right ventricle and between the left atrium and the left ventricle.

Between the right atrium and the right ventricle = <u>Tricuspid valve.</u>	1 mark
Between the left atrium and the left ventricle = <u>Bicuspid valve.</u>	1 mark
	Total: 2 marks

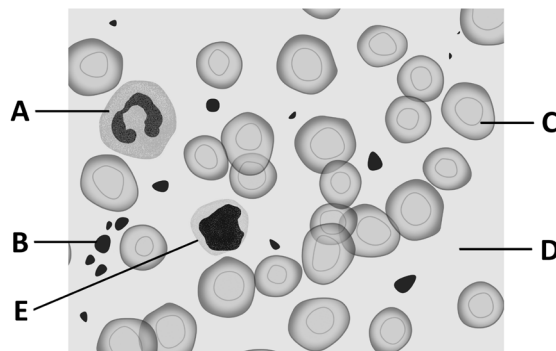
Sometimes, a damaged heart valve needs to be replaced. In some cases, valves from pig hearts can be used to replace damaged human heart valves.

- d) Suggest **one** advantage of using a pig heart valve compared to using a completely artificial valve.

Any <u>one</u> from the following:	
Lower risk of blood clots / less likely to cause blood clotting.	1 mark
Patient may not need to take anticoagulant / blood thinning medication (for life)	1 mark
Less chance of rejection (compared to some materials)	1 mark
	Total: 1 mark

(Total for Question 6 is 6 marks)

7. The figure below shows a small sample of blood as seen under a light microscope.



Identify and give the function of each labelled part of the figure above.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Correctly identifies at least two components OR correctly identifies at least one component and provides its accurate function.
Level 2	3 - 4	Correctly identifies at least three components and provides an accurate function for at least two of these. May identify A and E simply as 'White blood cell' with a general function (e.g., 'fights disease') applied to one or both
Level 3	4 - 5	Correctly identifies at least four components (A, B, C, D, E) and provides accurate, specific functions for at least three of these. Where both A and E are identified as WBCs, their different functions (phagocytosis vs antibody/antitoxin production) are distinguished, or specific cell types (phagocyte/lymphocyte) are named with correct functions.

Indicative content:	
A: Identification: Phagocyte. Function: Engulfs / ingests / destroys pathogens OR Phagocytosis B: Identification: Platelet(s) Function: (Involved in) blood clotting / forming a clot / scab. C: Identification: Red blood cell. Function: Transports / carries oxygen OR Contains haemoglobin (which carries oxygen). D: Identification: Plasma. Function: Transports substances (allow named examples like CO₂, urea, glucose, hormones, antibodies, heat) OR Carries blood cells / platelets OR Liquid part / matrix of blood. E: Identification: Lymphocyte Function: Produces antibodies OR Produces antitoxins	
Total: 5 marks	

(Total for Question 7 is 5 marks)