PE.AP3 Cardiovascular System: The Heart and Blood Vessels

Total Marks

AQA 8582 · Calculators not allowed · about 50 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The heart is a four-chambered muscular pump. Which chamber receives deoxygenated blood returning from the body?

- ☐ A) Left atrium
- ☐ B) Left ventricle
- ☐ C) Right atrium
- ☐ D) Right ventricle

(Total for Question 1 is 1 mark)

---

2 State the name of the blood vessel that carries deoxygenated blood from the body into the right atrium.

(Total for Question 2 is 1 mark)

---

3 Describe the complete pathway of blood through the heart, starting from the right atrium and ending at the aorta, naming each chamber and each valve the blood passes through in the correct order.

(Total for Question 3 is 6 marks)

4 The heart contains four valves, each preventing the backflow of blood.

(a) Name the valve found between the right atrium and the right ventricle. **(1)**

(b) Name the valve found between the left atrium and the left ventricle. **(1)**

(c) State the general function of the heart's valves. **(1)**

(Total for Question 4 is 3 marks)

---

5 Which blood vessel carries deoxygenated blood from the right ventricle to the lungs?

- ☐ A) Pulmonary vein
- ☐ B) Pulmonary artery
- ☐ C) Aorta
- ☐ D) Vena cava

(Total for Question 5 is 1 mark)

---

6 Explain why the wall of the left ventricle is much thicker and more muscular than the wall of the right ventricle.

(Total for Question 6 is 2 marks)

---

7 The body has a double circulatory system, made up of two separate circuits.

(a) Name the circuit that carries blood between the heart and the lungs. **(1)**

(b) Name the circuit that carries blood between the heart and the rest of the body. **(1)**

(Total for Question 7 is 2 marks)

8 Blood vessels are classified into three main types: arteries, veins and capillaries.

(a) State one structural feature of arteries that suits them to carrying blood away from the heart under high pressure. **(1)**

(b) State one structural feature of veins that helps prevent the backflow of blood as it returns to the heart at low pressure. **(1)**

(c) State one structural feature of capillaries that allows an efficient exchange of oxygen, carbon dioxide and nutrients with body tissues. **(1)**

(Total for Question 8 is 3 marks)

---

9 A cyclist's leg muscles need a much greater supply of oxygenated blood during a race than when at rest. Explain how the structure of an artery supplying the leg muscles is suited to delivering blood under high pressure during exercise.

(Total for Question 9 is 2 marks)

---

10 The heart rate response to exercise can be estimated using the formula: maximum heart rate (in beats per minute) = 220 minus age (in years).

A 15-year-old hockey player wants to estimate their maximum heart rate.

(a) Using the formula given, calculate the hockey player's estimated maximum heart rate. **(1)**

.....

(b) State why this figure is described as an 'estimated' maximum heart rate rather than an exact one. **(1)**

(Total for Question 10 is 2 marks)

11 A rower has a resting heart rate of 48 beats per minute, well below the average for an untrained adult. Explain why regular aerobic training, such as rowing, causes resting heart rate to decrease over time.

(Total for Question 11 is 2 marks)

---

12 State the term used to describe an abnormally low resting heart rate, commonly seen in highly trained endurance athletes.

(Total for Question 12 is 1 mark)

13 Table 1 gives descriptions of structures in the cardiovascular system, with the structure name missing.

Table 1

Part	Description of structure
(a)	Carries oxygenated blood from the left ventricle to the body
(b)	Carries deoxygenated blood from the right ventricle to the lungs
(c)	Carries oxygenated blood from the lungs to the left atrium
(d)	Carries deoxygenated blood from the body to the right atrium
(e)	Tiny blood vessels, one cell thick, where gas and nutrient exchange takes place

(a) Name the vessel described in row (a) of Table 1. **(1)**

(b) Name the vessel described in row (b) of Table 1. **(1)**

(c) Name the vessel described in row (c) of Table 1. **(1)**

(d) Name the vessel described in row (d) of Table 1. **(1)**

(e) Name the vessel described in row (e) of Table 1. **(1)**

(Total for Question 13 is 5 marks)

14 A swimmer takes part in a 12-week endurance training block. Their coach explains that this will increase the number of capillaries surrounding the muscles used in swimming.

(a) State the term used to describe this increase in the number of capillaries. **(1)**

(b) Explain how this adaptation benefits the swimmer's performance during a long-distance race. **(2)**

(Total for Question 14 is 3 marks)

---

15 A marathon runner's training programme is designed to improve the efficiency of their cardiovascular system.

Explain how long-term aerobic training adapts the heart and blood vessels, and evaluate how these adaptations help a named endurance performer, such as a marathon runner, sustain a fast pace for over two hours.

(Total for Question 15 is 6 marks)

---

16 Explain why the coronary arteries, which supply the heart muscle itself with oxygenated blood, are particularly important during intense exercise.

(Total for Question 16 is 2 marks)

17 Cardiac output is the term used to describe how much blood the heart pumps out in one minute.

(a) State what is meant by the term 'cardiac output'. **(1)**

(b) State the two factors, multiplied together, that determine cardiac output. **(1)**

(Total for Question 17 is 2 marks)

---

18 Cardiac output (in ml per minute) can be calculated using the formula: cardiac output = stroke volume x heart rate.

A swimmer has a stroke volume of 120 ml and a heart rate of 150 beats per minute during a race.

(Total for Question 18 is 2 marks)

---

19 Explain why cardiac output increases during exercise compared with at rest.

(Total for Question 19 is 2 marks)

---

20 The coronary arteries branch off the aorta and supply the heart muscle itself with oxygenated blood. Suggest what would happen to part of the heart muscle if one of the coronary arteries became blocked, for example by a blood clot.

(Total for Question 20 is 2 marks)

21 A pulse can be felt at several points on the body, such as the wrist or the neck.

(a) Name one point on the body where a pulse can be measured. **(1)**

(b) Explain what causes the pulse felt at this point. **(2)**

(Total for Question 21 is 3 marks)

Mark scheme · PE.AP3 Cardiovascular System: The Heart and Blood Vessels

Question 1

- **B1** C (right atrium)
- **Answer: C (right atrium)**

Question 2

- **B1** vena cava
- **Answer: Vena cava**

Question 3

- **B1** from the right atrium, blood passes through the tricuspid valve into the right ventricle
- **B1** from the right ventricle, blood passes through the pulmonary valve into the pulmonary artery, to the lungs
- **B1** at the lungs, blood becomes oxygenated (gas exchange), then returns via the pulmonary vein into the left atrium
- **B1** from the left atrium, blood passes through the bicuspid (mitral) valve into the left ventricle
- **B1** from the left ventricle, blood passes through the aortic valve into the aorta, to the body
- **B1** correct overall order maintained throughout (right atrium -> tricuspid -> right ventricle -> pulmonary valve -> pulmonary artery -> lungs -> pulmonary vein -> left atrium -> bicuspid/mitral -> left ventricle -> aortic valve -> aorta), oe wording
- **Answer: Right atrium -> tricuspid valve -> right ventricle -> pulmonary valve -> pulmonary artery -> lungs (blood is oxygenated) -> pulmonary vein -> left atrium -> bicuspid (mitral) valve -> left ventricle -> aortic valve -> aorta.**

Question 4

- (a) **B1** tricuspid valve
- **(a) Answer: Tricuspid valve**
- (b) **B1** bicuspid valve (mitral valve)
- **(b) Answer: Bicuspid valve (mitral valve)**
- (c) **B1** to prevent the backflow of blood (keeping blood flowing in one direction through the heart), oe
- **(c) Answer: To prevent the backflow of blood, keeping it flowing in one direction through the heart.**

Question 5

- **B1** B (pulmonary artery)
- **Answer: B (pulmonary artery)**

Question 6

- **B1** the right ventricle only has to pump blood a short distance to the lungs (pulmonary circulation), a low-pressure system, oe
- **B1** the left ventricle has to pump blood all the way around the rest of the body (systemic circulation), which needs a much greater force/higher pressure, so it needs thicker, more powerful muscle, oe
- **Answer: The right ventricle only needs to pump blood the short distance to the lungs (low pressure), whereas the left ventricle must pump blood all the way around the rest of the body (systemic circulation), which needs much greater force, so its wall is thicker and more muscular.**

Question 7

- (a) **B1** pulmonary circulation/circuit
- **(a) Answer: Pulmonary circulation**
- (b) **B1** systemic circulation/circuit
- **(b) Answer: Systemic circulation**

Question 8

- (a) **B1** thick, muscular/elastic walls, oe
- **(a) Answer: Thick, muscular and elastic walls.**
- (b) **B1** valves, oe
- **(b) Answer: Valves.**
- (c) **B1** walls that are only one cell thick, oe
- **(c) Answer: Walls that are only one cell thick.**

Question 9

- **B1** the thick, muscular and elastic wall can withstand the high pressure of blood being pumped strongly from the heart during exercise, oe
- **B1** the elastic wall can stretch and recoil with each heartbeat, helping to maintain a smooth, high-pressure flow of blood to the working muscles, oe
- **Answer: The artery's thick, muscular, elastic wall can withstand the high pressure of blood pumped strongly from the heart during exercise, and can stretch and recoil with each heartbeat, helping maintain a smooth, high-pressure flow of blood to the working leg muscles.**

Question 10

- (a) **B1** 205 bpm (220 - 15 = 205)
- **(a) Answer: 205 beats per minute**
- (b) **B1** the formula is a general average/prediction based on age alone; an individual's true maximum heart rate can vary from this due to genetics, fitness level and other individual factors, oe
- **(b) Answer: It is only an average prediction based on age; an individual's true maximum heart rate can vary from this figure due to genetics, fitness level and other individual factors.**

Question 11

- **B1** regular aerobic training causes cardiac hypertrophy (the heart muscle, especially the left ventricle, enlarges/thickens) and increases stroke volume (the volume of blood pumped out per beat), oe
- **B1** because more blood is pumped with each beat, the heart does not need to beat as often at rest to circulate the same amount of blood, so resting heart rate decreases (bradycardia), oe
- **Answer: Regular aerobic training causes cardiac hypertrophy and increases stroke volume, so more blood is pumped with each beat; because the same resting cardiac output can be achieved with fewer, stronger beats, resting heart rate decreases (a trained athlete's bradycardia).**

Question 12

- **B1** bradycardia
- **Answer: Bradycardia**

Question 13

- (a) **B1** aorta
- **(a) Answer: Aorta**
- (b) **B1** pulmonary artery
- **(b) Answer: Pulmonary artery**
- (c) **B1** pulmonary vein
- **(c) Answer: Pulmonary vein**
- (d) **B1** vena cava
- **(d) Answer: Vena cava**
- (e) **B1** capillaries
- **(e) Answer: Capillaries**

Question 14

- (a) **B1** capillarisation
- **(a) Answer: Capillarisation**
- (b) **B1** more capillaries around the working muscles increases the surface area available for the exchange of oxygen, nutrients and waste products between the blood and the muscle, oe
- (b) **B1** this allows more oxygen to reach the muscles and more carbon dioxide/lactic acid to be removed, delaying fatigue and improving endurance performance, oe
- **(b) Answer: More capillaries around the working muscles increases the surface area for exchanging oxygen, nutrients and waste with the blood, so more oxygen reaches the muscles and waste products are removed more efficiently, delaying fatigue and improving endurance performance.**

Question 15

- **Level 3** (5-6): A detailed and coherent answer that explains at least three distinct cardiovascular adaptations (e.g. cardiac hypertrophy, increased stroke volume, decreased resting heart rate, capillarisation) and clearly evaluates how each one helps a named endurance performer sustain performance, using accurate terminology throughout.
- **Level 2** (3-4): At least two cardiovascular adaptations are explained with reasonable accuracy, with some link made to sustained endurance performance, but the evaluation may be underdeveloped.
- **Level 1** (1-2): One or two relevant points about cardiovascular adaptations are made, with little explanation or clear link to endurance performance.
- **Level 0** (0): No relevant content.
- **Indicative content:**
  - Cardiac hypertrophy: the heart muscle, particularly the wall of the left ventricle, enlarges and thickens with regular aerobic training.
  - Increased stroke volume: a stronger, larger heart can pump more blood out with each beat, both at rest and during exercise.
  - Increased maximal cardiac output: because stroke volume increases, the maximum amount of blood the heart can pump per minute during hard exercise also increases, delivering more oxygen to the muscles.
  - Decreased resting heart rate (bradycardia): with a greater stroke volume, fewer beats are needed to circulate the same amount of blood at rest, allowing the heart more recovery time between beats.
  - Capillarisation: an increase in the number of capillaries around the muscles and alveoli, improving the exchange of oxygen, carbon dioxide and nutrients.
  - For a named marathon runner: a larger stroke volume and higher maximal cardiac output mean more oxygenated blood reaches the leg muscles per minute, delaying the point at which the muscles must rely on anaerobic energy production, helping the runner maintain a fast, mostly aerobic pace for over two hours without a rapid build-up of fatigue.
  - A lower resting and submaximal heart rate also means the heart works more efficiently at a given pace, leaving greater cardiovascular reserve for later stages of the race, such as a final surge.

Question 16

- **B1** the coronary arteries supply the heart's own muscle (the myocardium) with oxygenated blood, oe
- **B1** during intense exercise the heart works much harder/faster and needs more oxygen itself to keep contracting powerfully, so an adequate supply through the coronary arteries is essential to prevent the heart muscle fatiguing, oe
- **Answer: The coronary arteries supply the heart's own muscle with oxygenated blood; during intense exercise the heart works much harder and needs more oxygen itself to keep contracting powerfully, so an adequate coronary blood supply is essential to prevent the heart muscle fatiguing.**

Question 17

- (a) **B1** the volume of blood pumped out by the heart (by one ventricle) in one minute, oe
- **(a) Answer: The volume of blood pumped out by the heart in one minute.**
- (b) **B1** stroke volume and heart rate, oe
- **(b) Answer: Stroke volume and heart rate.**

Question 18

- **M1** 120 x 150 seen/attempted
- **A1** 18000 ml/min (accept 18 litres/min), cao
- **Answer: 18000 ml per minute (18 litres per minute)**

Question 19

- **B1** both stroke volume and heart rate increase during exercise, oe
- **B1** because cardiac output = stroke volume x heart rate, an increase in either (or both) increases cardiac output, delivering more oxygenated blood to the working muscles to meet their increased demand, oe
- **Answer: Both stroke volume and heart rate increase during exercise, and because cardiac output = stroke volume x heart rate, this increases cardiac output, delivering more oxygenated blood to the working muscles to meet their greater demand for oxygen.**

Question 20

- **B1** the area of heart muscle normally supplied by that artery would receive a reduced/no supply of oxygenated blood, oe
- **B1** without enough oxygen this heart muscle tissue could be damaged or start to die, which can cause a heart attack (myocardial infarction), oe
- **Answer: The area of heart muscle normally supplied by that coronary artery would receive little or no oxygenated blood, so it could become damaged or start to die from lack of oxygen, which is what happens during a heart attack (myocardial infarction).**

Question 21

- (a) **B1** any one of: wrist (radial pulse) / neck (carotid pulse)
- **(a) Answer: For example, the wrist (radial pulse).**
- (b) **B1** each time the left ventricle contracts, it forces a surge of blood into the arteries, oe
- (b) **B1** this surge of pressure can be felt as a pulse where an artery lies close to the skin, so the pulse rate is the same as the heart rate, oe
- **(b) Answer: Each time the left ventricle contracts, it forces a surge of blood into the arteries; this surge of pressure can be felt as a pulse where an artery runs close to the skin, so the pulse rate matches the heart rate.**