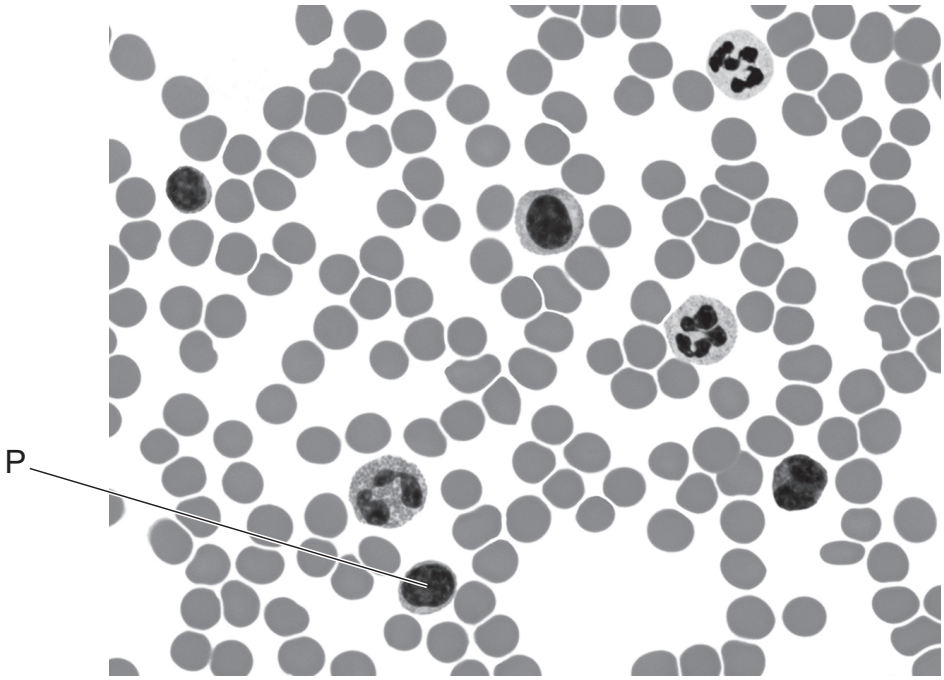
**31** The body maintains an average normal blood pH of 7.4.

Which row describes the conditions that would increase the dissociation rate of haemoglobin the most during periods of intense exercise?

| | blood pH | blood $CO_2$ partial pressure / kPa |
|---|---|---|
| **A** | 7.2 | 5.6 |
| **B** | 7.2 | 9.5 |
| **C** | 7.6 | 5.6 |
| **D** | 7.6 | 9.5 |



**33** The photomicrograph shows cells found in mammalian blood.




What is cell P?

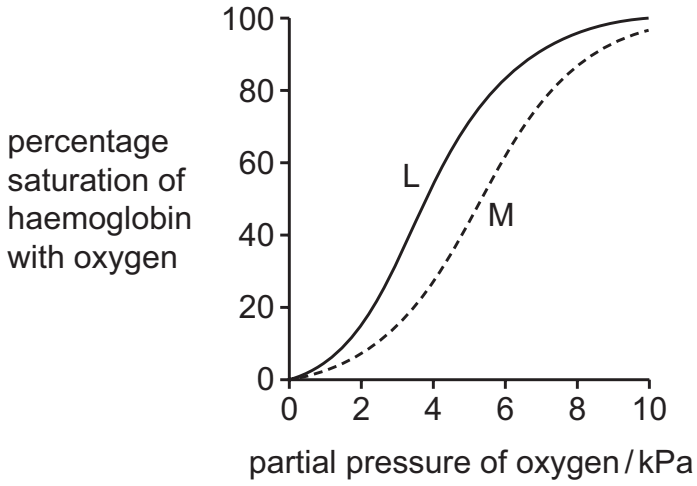
**A** lymphocyte

**B** monocyte

**C** neutrophil

**D** red blood cell

**34** The diagram shows the Bohr shift in actively respiring cells.




What causes the shift from L to M?

**A** Carbonic acid dissociates to release protons that bind to oxyhaemoglobin, affecting the conformation of haemoglobin to reduce its affinity for oxygen.

**B** Hydrogencarbonate ions produced by carbonic anhydrase alter the charge of oxyhaemoglobin, reducing its ability to bind oxygen.

**C** Hydrogen ions combine with chloride ions in tissue fluid to produce hydrochloric acid, distorting oxyhaemoglobin and causing it to lose bound oxygen.

**D** A low concentration of oxygen in actively respiring cells causes oxyhaemoglobin to release oxygen more quickly down the concentration gradient.



**32** Red blood cells may contain a molecule known as 2,3-bisphosphoglycerate (2,3-BPG).

When 2,3-BPG binds to haemoglobin, a higher partial pressure of oxygen is needed to bring about 50% saturation of haemoglobin with oxygen.

Which statements about the effect of 2,3-BPG are correct?

1 2,3-BPG in red blood cells causes the oxygen dissociation curve to shift to the right.

2 The binding of 2,3-BPG to haemoglobin reduces the Bohr effect.

3 The binding of 2,3-BPG to haemoglobin lowers the affinity of the haemoglobin for oxygen.

**A** 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

**33** Which statement correctly describes the Bohr shift?

**A** the decrease in affinity of haemoglobin for oxygen that occurs when pH is lowered

**B** the increase in affinity of haemoglobin for oxygen that occurs when oxygen concentration rises

**C** the increase in affinity of haemoglobin for oxygen that occurs when pH is at an optimum

**D** the release of oxygen from oxyhaemoglobin in the absence of carbonic acid



**2** **(a)** Haemoglobin is a globular protein containing haem groups.

Explain how the presence of haem groups allows the haemoglobin molecule to transport oxygen.

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**(b)** In certain situations, such as during intense exercise, a person may breathe very quickly and deeply. This is known as hyperventilation.

This hyperventilation causes more carbon dioxide to be exhaled. As a result, there is a lower concentration of carbon dioxide in the blood that passes through the capillary network in respiring tissues. This increases the affinity of haemoglobin for oxygen so that there is a decrease in the release of oxygen from red blood cells.

Explain why a decrease in the concentration of carbon dioxide in the blood passing through respiring tissues leads to a decrease in the release of oxygen from red blood cells.

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**(c)** Fig. 2.1 is a diagram of a section through the heart.

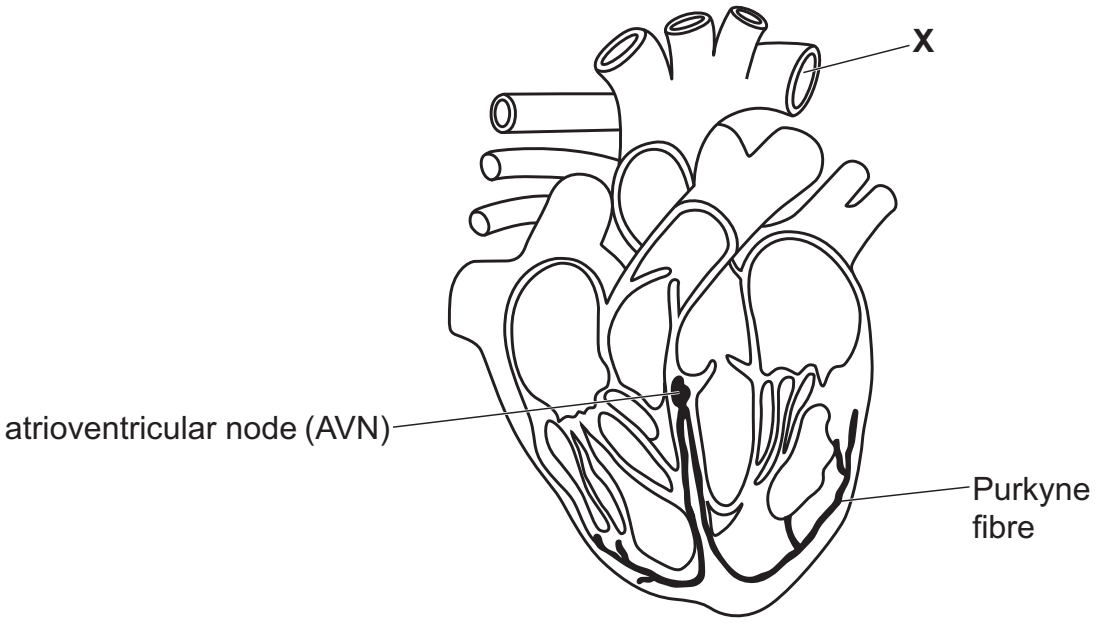


**Fig. 2.1**

**(i)** Describe and explain how the tunica media (middle layer of the wall) of blood vessel **X** adapts the blood vessel for its function.

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**(ii)** Describe the role of the atrioventricular node (AVN) and the Purkyne tissue in the cardiac cycle.

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[Total: 12]

**6** In the pulmonary circulation of a mammal, deoxygenated blood becomes oxygenated when red blood cells pass through alveolar capillaries and haemoglobin within the cells combines with oxygen.

The blood returns to the heart to be pumped around the systemic circulation.

**(a)** Describe the sequence of events occurring in the heart that allows blood returning in the pulmonary circulation to then enter the systemic circulation.

You should include in your description:

- the names of the relevant blood vessels of the pulmonary circulation and systemic circulation that are connected to the heart
- reference to blood pressure changes that cause the opening and closing of valves.

You **do not** need to include details of control of the cardiac cycle.

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**(b)** Fig. 6.1 is a drawing of a haemoglobin molecule to show its globular structure.

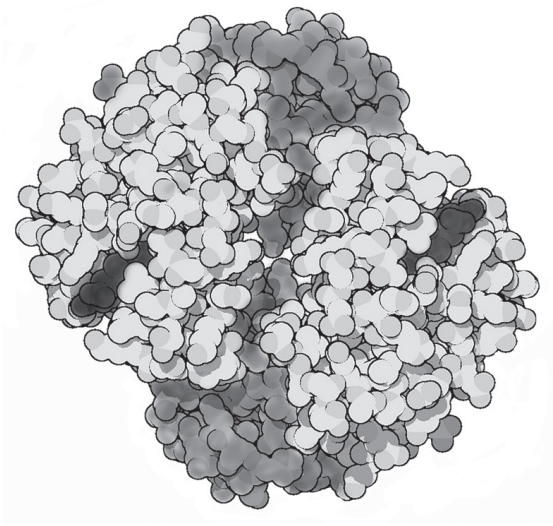

**Fig. 6.1**

**(i)** Describe the quaternary structure of a haemoglobin molecule.

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**(ii)** Outline how a haemoglobin molecule can become fully saturated with oxygen to form oxyhaemoglobin.

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[Total: 9]