Transport in animals

Model Answers 1

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Exchange and transport
Topic	Transport in animals
Booklet	Model Answers 1

Time allowed: **62 minutes**

Score: **/46**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>69%	56%	50%	42%	34%	26%

Question 1

A student investigated the heart rates of smokers and non-smokers.

- Each test subject had their resting heart rate measured using an electronic heart rate monitor.
- They ran 1 km on a running track and their heart rate after running 500 m was recorded.
- Their heart rate was recorded for a third time 3 minutes after the completion of the exercise.

All test subjects were 18 years old. Subjects were tested between 9 am and 4 pm on one day, one at a time. Each test lasted approximately 20 minutes in total. The tests were repeated one week later using the same method. Mean heart rates were calculated for each subject.

The student's plan was to compare the heart rates of smokers and non-smokers using Student's *t*-test.

The student's results are shown in Table 6.

Student	Smoker?	Gender	Resting heart rate (bpm)	Heart rate during exercise	Heart rate after exercise
1	Y	Male	60.5	130.0	66.5
2	N	Female	67.0	145.5	73
3	Y	Male	70.0	120	77.0
4	Y	Male	65.5	100	69
5	Y	Male	66.0	128.5	75.5
6	Y	Female	65.5	115.5	74.5
7	Y	Female	73.5	120.5	81
8	N	Female	63.0	118	66
9	N	Female	71.0	95.5	80.5
10	N	Female	65.5	110	71
11	N	Male	64.0	145.5	68
12	N	Male	52.5	140.0	58.5
13	N	Male	54.0	137.5	63
14	N	Female	73.0	130.5	81
15	N	Female	61.5	124	67
16	N	Female	71.0	130	81.5
17	N	Male	60.0	122.5	63
18	N	Female	64.5	118	69
19	N	Female	67.5	130.5	73.5
20	Y	Male	72.0	135	82
21	Y	Female	69.5	110	75.5

Table 6

Suggest and explain improvements that the student could make to his experimental method **and** his presentation of data.

In your answer you should explain the benefits of your suggested improvements. **[6]**

- Gender should be tested separately as this could cause an overall difference in heart rates
- The sample size should be greater to improve repeatability
- The health issues/diet of the subjects was not recorded/screening did not take place
- The same number of smokers and non-smokers should be included (8 smokers out of 21)
- The speed/effort they ran the 1km was not controlled
- The time of day should have been standardised as this was too broad (7 hours)
- The number of cigarettes smoked was not standardised
- More repeats to identify anomalies before calculating the mean
- Smokers and non-smokers should have been presented as separate columns
- Units should be included for heart rate
- The number of decimal places should have been consistent in each column
- The data should be presented as a graph so that trends can be seen more easily

This type of question is much more common now that practicals form a core of the A level specification.

Remember control variables, sample size, repeats and presentation of data.

[Total: 6]

Question 2

(a) Fig. 5.1, **on the insert**, shows the circulatory systems of three groups of animals.

(i) What type of circulatory system is shown in **all** these animals? **[1]**

Closed circulatory system

In a closed circulatory system the blood stays in blood vessels at all times. This allows it to create more pressure

(ii) How does the circulatory system of a fish compare to that of a mammal? **[1]**

The fish has a single circulation and the mammal has a double

In a double circulation, blood returns to the heart after it has been to the lungs, so it can be forced out under higher pressure. In fish the blood continues from the gills to the tissues.

(b)* Fig. 5.2, **on the insert**, shows the flow of blood through the heart of an amphibian such as a frog.

Use the information in Fig. 5.1 **and** Fig. 5.2 to compare the circulations of a frog and a mammal and the relative effectiveness of each type of circulation. **[6]**

- Both have double circulations
- Blood from the heart is delivered to the lungs and body separately
- Oxygenated blood and deoxygenated blood never mix in mammals
- Blood from the heart is delivered to the lungs and body together in the frog
- Blood going to the body in the frog is mixture of oxygenated and deoxygenated
- The frog circulation is less effective
- Frog's could have lower metabolic rate as oxygen supply is less to the tissues
- Frogs also oxygenate their blood in the mouth and skin
- Mammals have a faster metabolism
- Mammals sustain their body temperatures using the heat energy produced by a fats respiration rate

This question needs you to think outside the box, try to explain why frogs could sustain a mixture of oxygenated and deoxygenated blood. In mammals there is a wall or septum between the two ventricles which prevents the blood from the lungs and the rest of the body from mixing, this makes the circulatory system more efficient.

[Total: 8]

Question 3

(a) The electrical activity of the heart can be monitored using an electrocardiogram (ECG) trace.

Fig. 16.1 shows the ECG pattern for a single normal heartbeat.

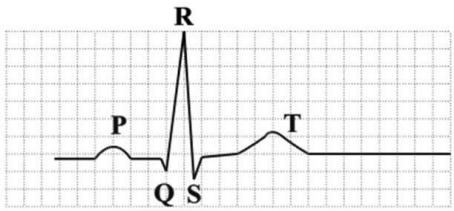


Fig. 16.1

Fig. 16.2 shows an ECG trace for a person with normal heart rhythm and **Fig. 16.3** shows the trace for a person with tachycardia.

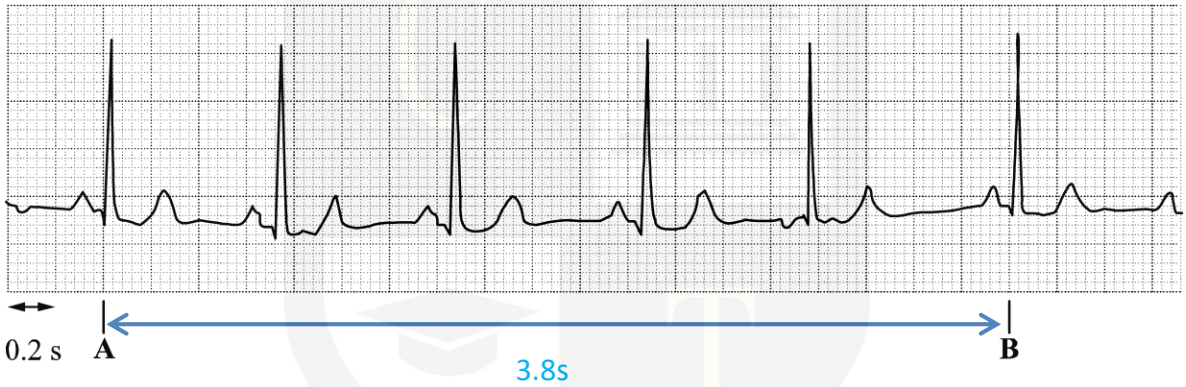


Fig. 16.2

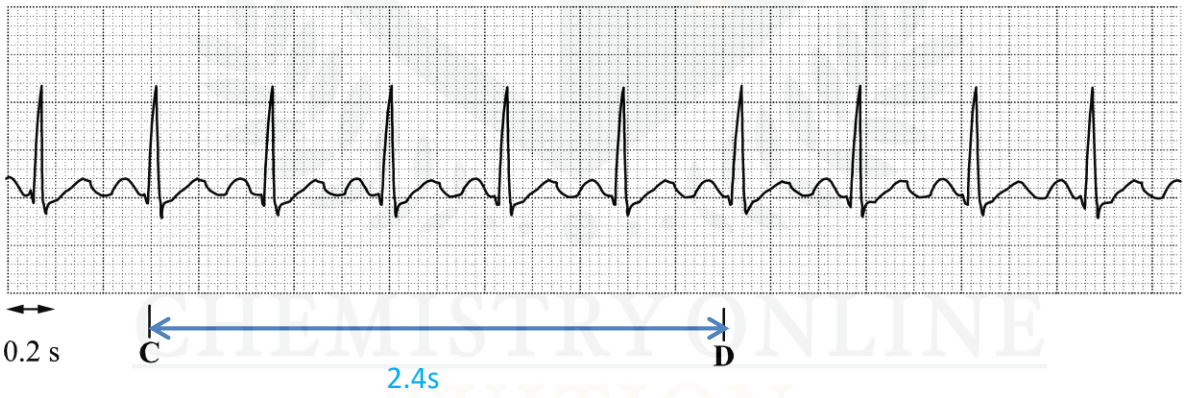


Fig. 16.3

(i) Calculate the percentage increase in heart rate for the person with tachycardia compared to the person with normal heart rhythm.

Use the data between points **A** and **B** on **Fig. 16.2** and points **C** and **D** on **Fig. 16.3** for your calculations.
Give your answer to the nearest whole number. **[4]**

- % increase = ((2.5 - 1.58) ÷ 1.58) x 100 = 58%

rate of normal heart rate = 6/3.8 = 1.58

rate of tachycardia heart rate = 6/2.4 = 2.5

(ii) The most obvious feature of tachycardia is an increased heart rate.

Using the information in **Fig. 16.1**, **Fig. 16.2** and **Fig. 16.3**, what are **other** key features of tachycardia?

[2]

- The peaks are shorter (QRS)
- P and T waves are the same height
- T waves are wider

Use the diagram in fig 1 to help you to refer to the various letters associated with an ECG

(b) **Fig. 16.4** is an ECG trace of a person with an abnormal heart rhythm.

Fig. 16.4

Using the information from **Fig. 16.4**, what conclusions can you draw about the way in which this person's heart is functioning abnormally?

[3]

- There is no distinct P wave
- Atrial contraction is weak
- Less blood is forced into the ventricles
- Less blood is forced from the heart

Electrical conductivity is at fault here, it is known as atrial fibrillation and can be caused by a faulty AV node

[Total: 9]

Question 4

(a) Table 5.1 and Table 5.2 list events that occur during the cardiac cycle.

Each event in Table 5.1 is immediately followed by one of the events listed in Table 5.2.

Complete Table 5.1 by inserting the appropriate letters of the events from Table 5.2.

The first row has been completed for you. **[4]**

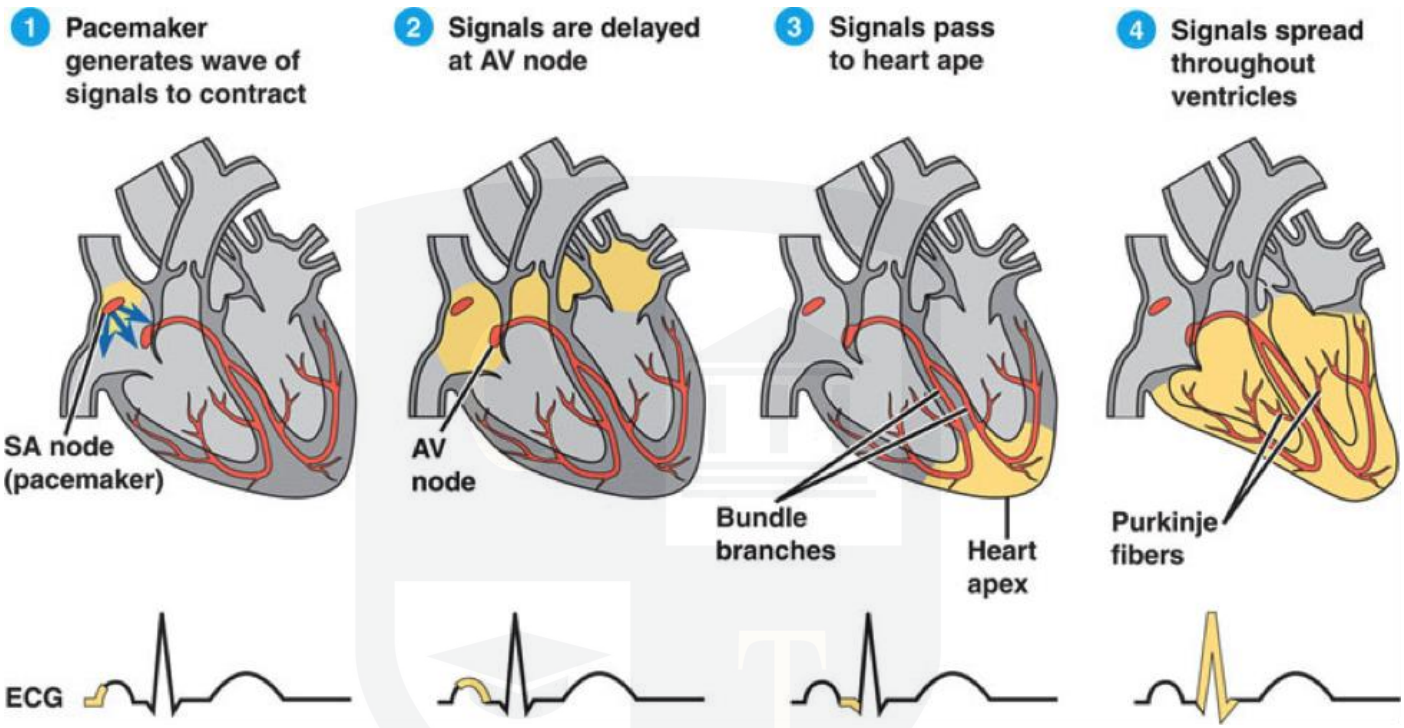
Event in the order in which they occur	**Letter describing the event that follows**
atrial walls start to relax	D
sinoatrial (SA) node generates electrical signals	C
atrioventricular (AV) node receives electrical signals from SA node	E
ventricle walls start to contract	A
ventricle walls relax	B

Table 5.1

Event	**Letter**
atrioventricular valves close	A
semilunar valves close	B
walls of atria contract	C
ventricle walls start to contract	D
electrical signals transmitted down septum	E

Table 5.2

A diagram to show the events during a cardiac cycle:



(b) Fig. 5.1 shows a normal ECG trace. The electrical activity of the heart is measured in millivolts (mV).

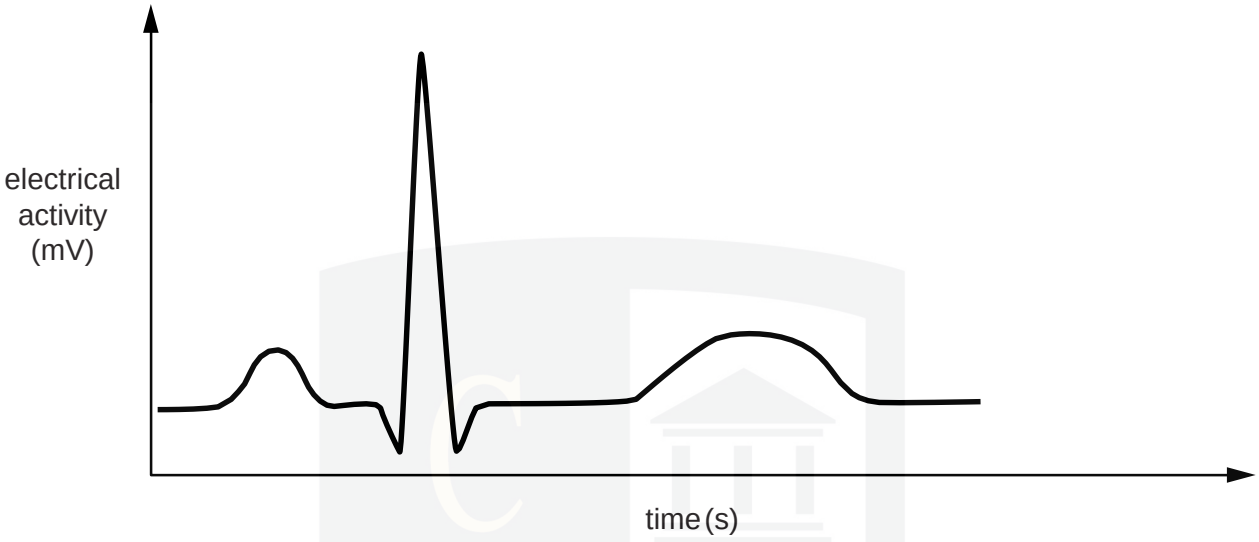


Fig. 5.1

In a condition known as supraventricular tachycardia, electrical signals leak from the atrial walls directly to the top of the ventricles. This causes the ventricle walls to contract twice for every atrial contraction.

(i) Using the axes below, sketch an ECG trace that might be expected in a patient with this condition.

[1]

P wave (atrial contraction) should be combined with the larger peak of QRS complex as signals leak directly from atria to ventricles.

(ii) Suggest and explain what effect supraventricular tachycardia might have on blood flow from the heart.

[2]

- Supraventricular tachycardia results in **less blood leaving the heart** for each ventricular contraction
- This is because the **ventricles do not have time to fill** before contraction

Note that the contraction here would start at the top of the ventricles, pushing blood down away from major arteries; this is not an efficient heartbeat.

(c) The blood circulatory system of a mammal undergoes changes at, or soon after, birth.

(i) One of these changes is that the foramen ovale, a hole in the septum between the right and left atria, closes. In the fetus, the foramen ovale allows blood to flow directly from the right atrium to the left atrium.

Suggest why the foramen ovale is open in the fetus before birth. **[2]**

- The foramen ovale is open as a fetus because the lungs are not **functional**
- This means that blood is not **oxygenated** in the lungs
- So the lungs are **bypassed**

(ii) Another change occurring after birth is that fetal haemoglobin is replaced with adult haemoglobin.

State one difference between fetal haemoglobin and adult haemoglobin **and** give one reason why this difference is essential to the fetus.

[2]

- *Difference*: fetal haemoglobin has a **higher affinity for oxygen** than adult haemoglobin
- *Reason*: Because fetal haemoglobin must be able to bind oxygen in **lower partial pressures** as experienced in the placenta

OR

- Difference: fetal haemoglobin contains gamma sub-units
- Reason: the creates a higher affinity for oxygen.

This question is about the adaptations of fetal haemoglobin so that it can remove oxygen from maternal blood in order for the fetus to gain sufficient oxygen for aerobic respiration. A 'higher affinity', means that it binds more easily.

[Total: 11]

Question 5

(a) Blood contains erythrocytes and neutrophils.

Tissue fluid may contain neutrophils but does not contain erythrocytes.

Tissue fluid is formed from plasma by pressure filtration through the capillary walls.

All materials exchanged between the blood and cells pass through the capillary wall.

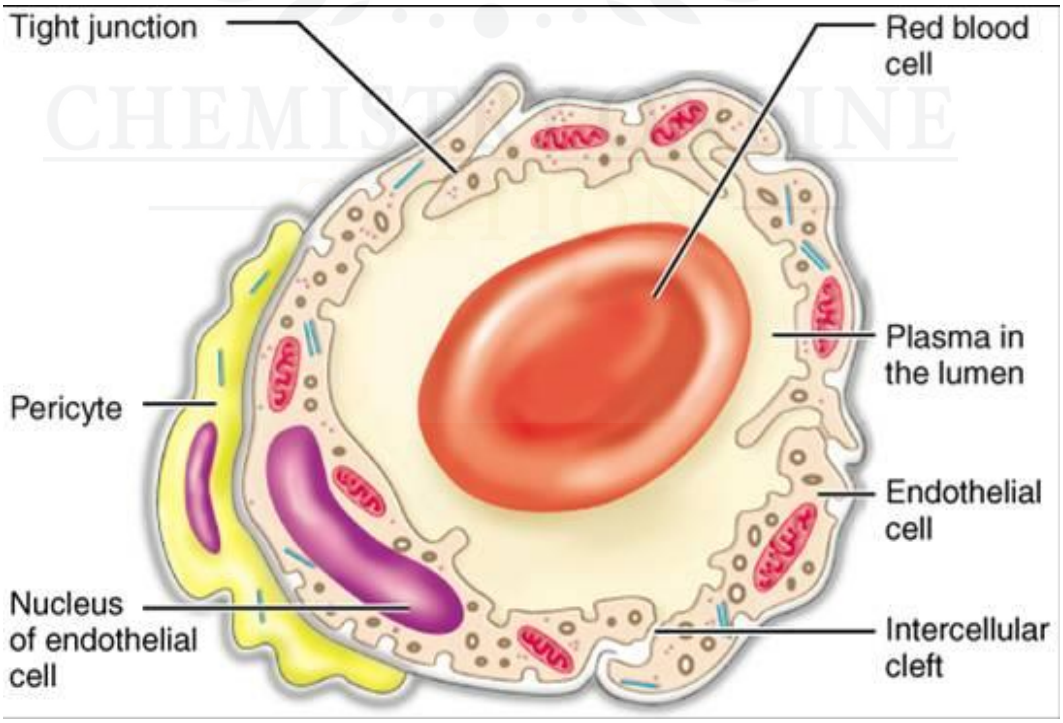
Explain why tissue fluid does not contain erythrocytes. **[2]**

Tissue fluid does not contain erythrocytes because:

- The gaps between the **endothelial** cells of capillaries are too **small**
- Erythrocytes are **too** large and are unable to change shape sufficiently
- To fit through the pores/gaps between endothelial cells

Exam tip: *to gain marks you need to talk about the physical structures (i.e. that the capillary has an endothelium with pores) and the relative size of the erythrocyte (i.e. too big to fit through)*

Diagram to show the cross section of a capillary, showing the endothelium with pores and the relative size of the erythrocyte:



(b) Erythrocytes are full of haemoglobin.

Describe the role of haemoglobin in transporting oxygen around the body. **[3]**

- Haemoglobin has a **high affinity** for oxygen
- Oxygen binds to haemoglobin in the **lungs** (at a high pO_2)
- To form **Oxyhaemoglobin**
- Oxygen is released in the tissues, where respiration is occurring (at a low pO_2)

Exam tip: *ensure you use correct scientific language here: i.e. 'binding' and 'releasing', rather than 'picking up' and 'dropping off'. Also do not say 'oxygen dissociates', as this implies that oxygen is forming ions.*

(c) Most carbon dioxide is transported as hydrogencarbonate ions in the plasma.

Hydrogencarbonate ions are produced in the erythrocytes and diffuse into the plasma.

(i) Describe how the hydrogencarbonate ions are **produced** in the erythrocytes.

In your answer you should use appropriate technical terms, spelled correctly.

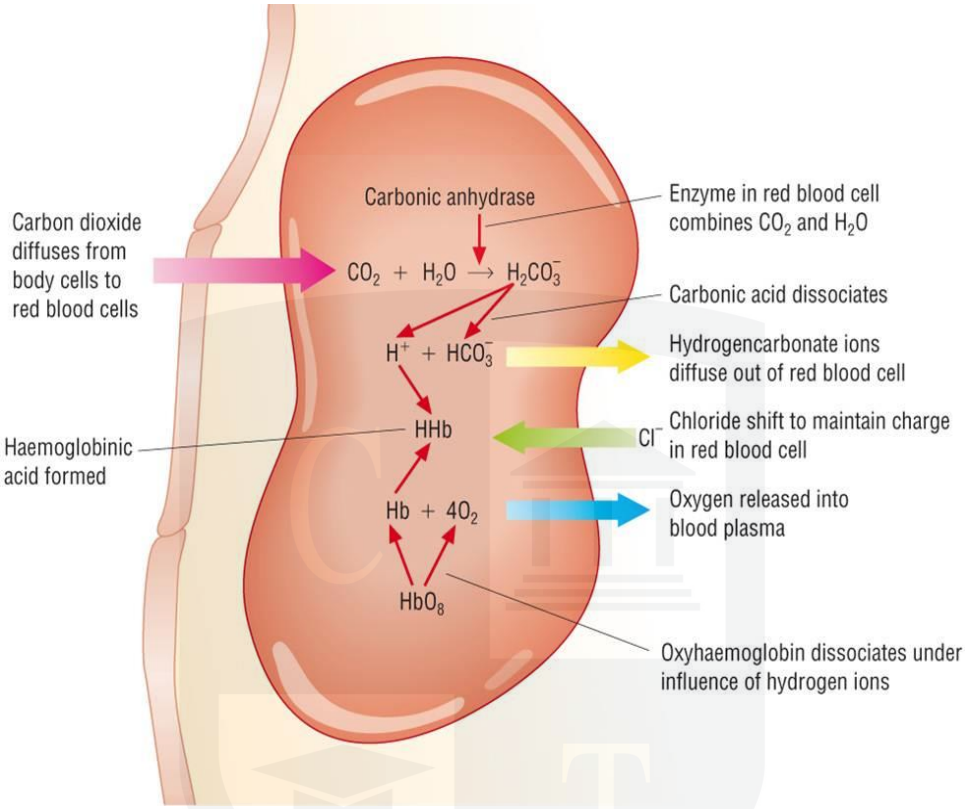
[4]

Hydrogencarbonate ions are produced by:

- Carbon dioxide **diffusing** into erythrocyte
- Carbon dioxide reacts with **water**
- To form **carbonic acid**
- Catalysed by the enzyme **carbonic anhydrase**
- Carbonic acid then **dissociates** to form **hydrogencarbonate ions** and **hydrogen ions**

Exam tip: *to gain the QWC mark here, you should use the scientific names, shown here in bold.*

Diagram to show the formation of hydrogencarbonate ions in the blood:



(ii) High concentrations of carbon dioxide in the blood reduce the amount of oxygen transported by haemoglobin.

Name this effect and explain why it occurs. **[3]**

name Bohr Shift

explanation

- High concentrations of carbon dioxide **reduces** the **affinity** of haemoglobin for oxygen
- Hydrogen ions bind with haemoglobin to form **haemoglobinic acid** (HHb)
    - This **prevents** a build-up of H+/ **fall in pH** in the erythrocytes
- This alters the **shape** of **haemoglobin**
- Allowing **more** oxygen to be released where it is required
- Carbon dioxide binds to haemoglobin forming **carbaminohaemoglobin**

This last point is relevant as it explains a reason for reduced oxygen transport

Note: *do not write about 'oxygen released more quickly/easily', or about 'oxygen dissociating' as both of these are incorrect.*

[Total: 12]