Q1.

Write an essay on the mechanisms and importance of transport within organisms.

(Total 25 marks)

Q2.

(a) This question is about the flow of blood into and through the heart.

Add the numbers 1 to 6 to the table below to give the order of structures through which blood will pass as it enters the heart and flows through the left ventricle.

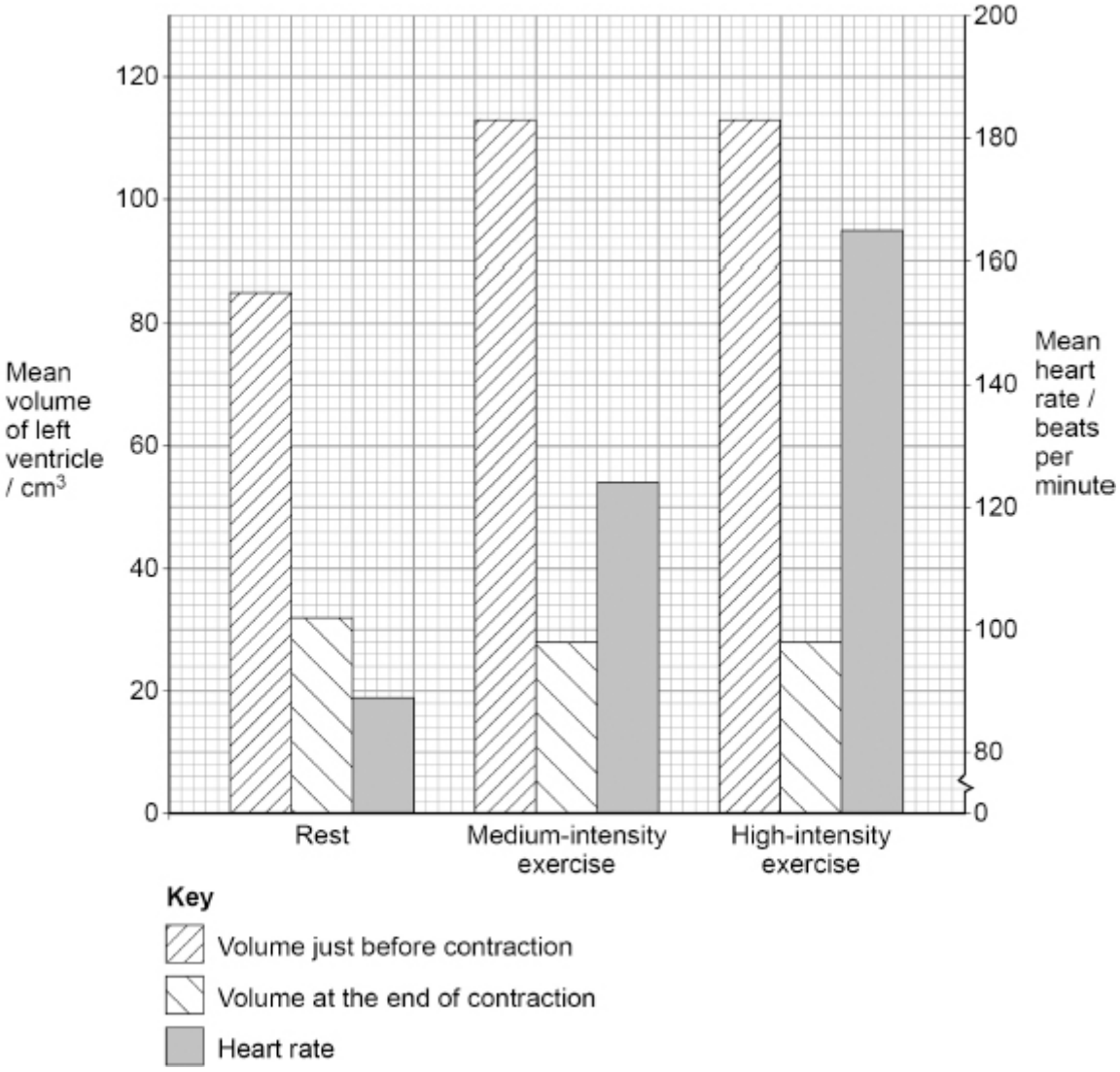
Use each number only once. Number **4** has been done for you.

Aorta		Pulmonary vein	
Left atrioventricular valve		Left semi-lunar valve	
Right atrioventricular valve		Vena cava	
Left atrium		Left ventricle	**4**
Right atrium		Right ventricle	
Pulmonary artery		Right semi-lunar valve	

(2)

(b) Scientists investigated the heart activity of humans at rest, during medium-intensity exercise and during high-intensity exercise.

The graph below shows the scientists' results.



Stroke volume = volume of blood leaving a ventricle with each contraction
Cardiac output = stroke volume × heart rate

Use all the information to describe what causes the increase in cardiac output:

- from rest to medium-intensity exercise
- from medium-intensity exercise to high-intensity exercise.

You do **not** need to calculate cardiac output to answer this question.

Rest to medium-intensity exercise _____

_____

_____

_____

Medium-intensity exercise to high-intensity exercise _____

_____

_____

_____

(2)

(c) Name the type of blood vessel that controls blood flow to muscles **and** explain how these blood vessels change blood flow during exercise.

Name of blood vessel _____

Explanation _____

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Q3.

(a) A student investigated a method for estimating the concentration of protein in solution by using a measure of the density of the solutions.

Copper sulfate solutions of different concentration have known densities, so they can be used to measure the density of other solutions.

The student prepared a dilution series of a copper sulfate solution.

Complete **Table 1** by giving all headings, units and volumes required to make 30 cm^3 of the concentration of the copper sulfate solution shown.

Table 1

Concentration of copper sulfate solution / g kg^{-1}	**Volume of 100 g kg^{-1} copper sulfate solution / _____**	**Volume of water / _____**
75	_____	_____

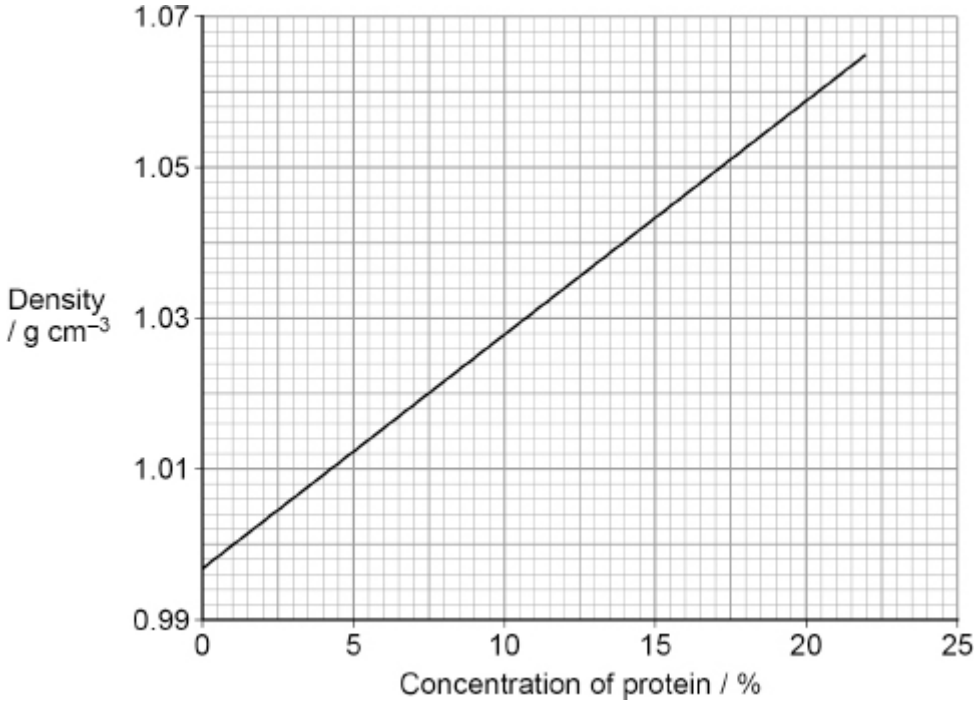
(2)

(b) **Table 2** shows the densities of the dilution series of the copper sulfate solution.

Table 2

Concentration of copper sulfate solution / g kg^{-1}	**Density of solution / g cm^{-3}**
0	0.997
25	1.014
50	1.030
75	1.048
100	1.065

The graph below shows the densities of protein solutions of different concentration.



The student put one drop of 10% protein solution into each of the copper sulfate solutions shown in **Table 2**.

Using the graph, he predicted that the drop would sink in the 0 and 25 g kg^{-1} copper sulfate solutions and float in the 50, 75 and 100 g kg^{-1} copper sulfate solutions.

Give the density of the 10% protein solution **and** explain why the student predicted that the drop would sink in the 25 g kg^{-1} copper sulfate solution.

Density of 10% protein solution _____ g cm^{-3}

Explanation _____

_____

_____

_____

_____

_____

(2)

(c) State the range of possible concentrations of a protein solution that sinks in 75 g kg^{-1} copper sulfate solution and floats in 100 g kg^{-1} copper sulfate solution.

Minimum concentration _____ %

Maximum concentration _____ %

(1)

(d) Blood donation involves healthy donors giving blood that can be used to treat hospital patients.

When donors arrive, the haemoglobin concentration of their blood is tested.

A sample of each donor's blood is added to a copper sulfate solution to determine whether the haemoglobin concentration is high enough to donate.

Errors sometimes occur with this test.

Tom has a concentration of haemoglobin high enough to donate.

Lucy has a concentration of haemoglobin too low to donate.

Evaluate the consequences of errors occurring when Tom's and Lucy's blood samples are tested.

Consequences of measurement error for Tom's blood _____

_____

_____

_____

_____

_____

Consequences of measurement error for Lucy's blood _____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

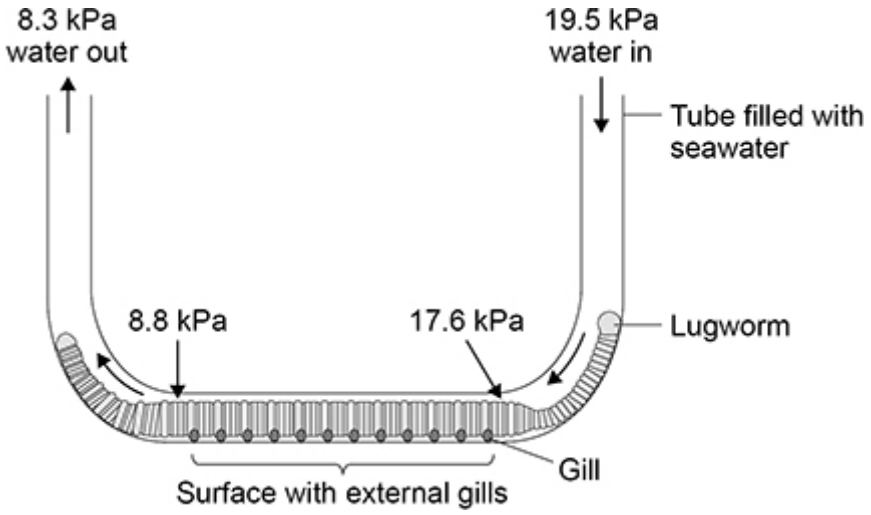
Q4.

(a) Lugworms create tubes in the sand on seashores. The tubes are filled with seawater.

A scientist measured the partial pressure of dissolved oxygen (pO_2) in seawater at different places in a tube with a lugworm inside.

Figure 1 shows her results.

Figure 1



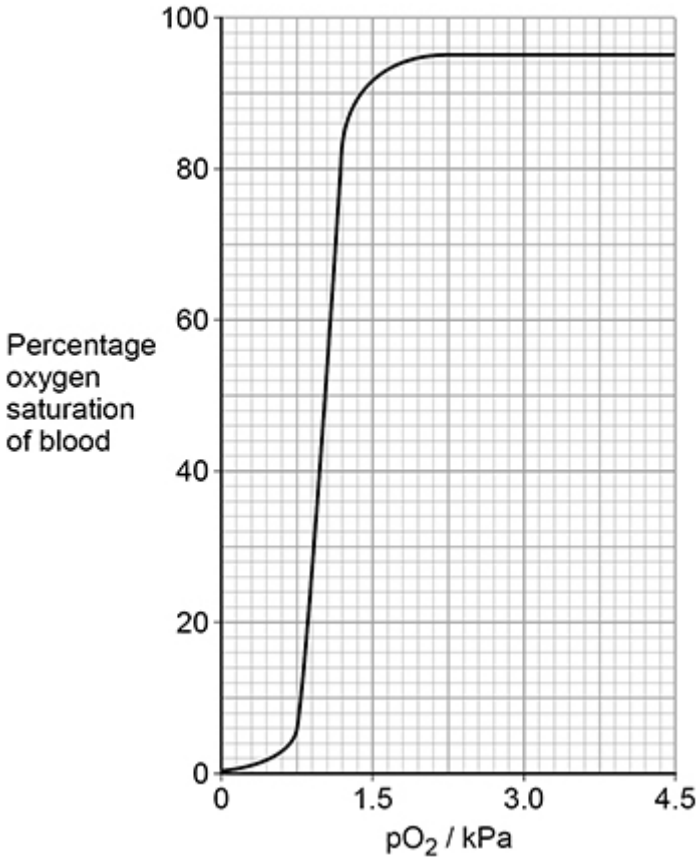
The pO_2 of dissolved oxygen in lugworm blood is < 2.7 kPa

Using the data in **Figure 1**, what can you conclude about the uptake of oxygen over the entire body of the lugworm?

(4)

(b) **Figure 2** shows the oxyhaemoglobin dissociation curve for a lugworm.

Figure 2



The oxygen saturation in the blood of a lugworm is 92%

The lugworm has 0.2 cm^3 of blood.

Calculate the volume of dissolved oxygen in the blood of this lugworm using this equation

$$pO_2 = \frac{CdO_2}{0.000\ 031}$$

CdO_2 is the concentration of dissolved oxygen in the blood, with units cm^3 oxygen per cm^3 of blood.

Show your working.

Answer _____ cm^3

(3)

(c) The intensity of the red colour in blood is affected by the pO_2 of the blood. The intensity of the colour in a solution is measured using a colorimeter.

The scientist used a colorimeter to measure the intensity of red colour in samples of lugworm blood with different pO_2 values. She prepared a calibration curve with this information.

Describe how the scientist will use information from the colorimeter and her calibration curve to determine the pO_2 in a sample of lugworm blood.

_____

_____

_____

_____

_____

(2)

(Total 9 marks)

Q5.

(a) Explain a property of iron ions that enables these ions to carry out their role in red blood cells.

_____

_____

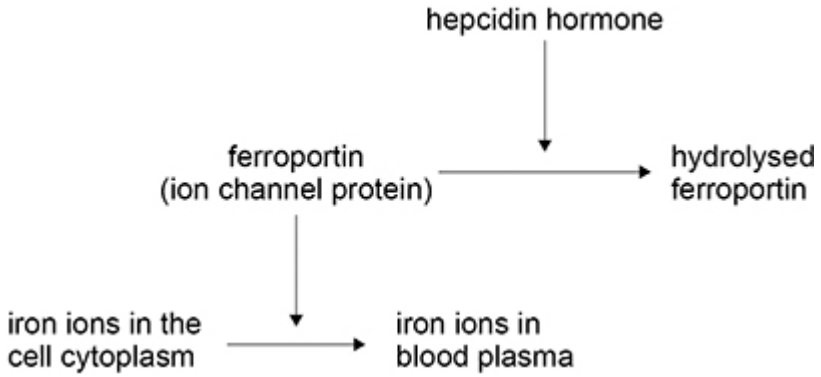
_____

_____

(2)

(b) The hormone hepcidin controls the iron ion concentration in blood plasma. Hepcidin affects ferroportin, the iron ion channel protein in cell-surface membranes.

The figure below shows how hepcidin controls the iron ion concentration in plasma.



People with the disease haemochromatosis do **not** produce hepcidin.

Use information in above figure to explain why the iron ion concentration is higher in the plasma of people with haemochromatosis.

_____

_____

_____

_____

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_____

_____

_____

(3)

(c) The mass of iron ions in the plasma of a person with haemochromatosis is 6104 µg The iron ion concentration in the plasma of a healthy person is 50 µg dm^{-3} The volume of blood in each of these people is 4000 cm^3

Calculate the ratio of the mass of iron ions in the plasma of the person with haemochromatosis to the mass of iron ions in the plasma of the healthy person.

Answer _____

(2)

(Total 7 marks)

Q6.

(a) A student dissected a sheep's heart. He prepared a risk assessment on:

- carrying a scalpel
- using a scalpel.

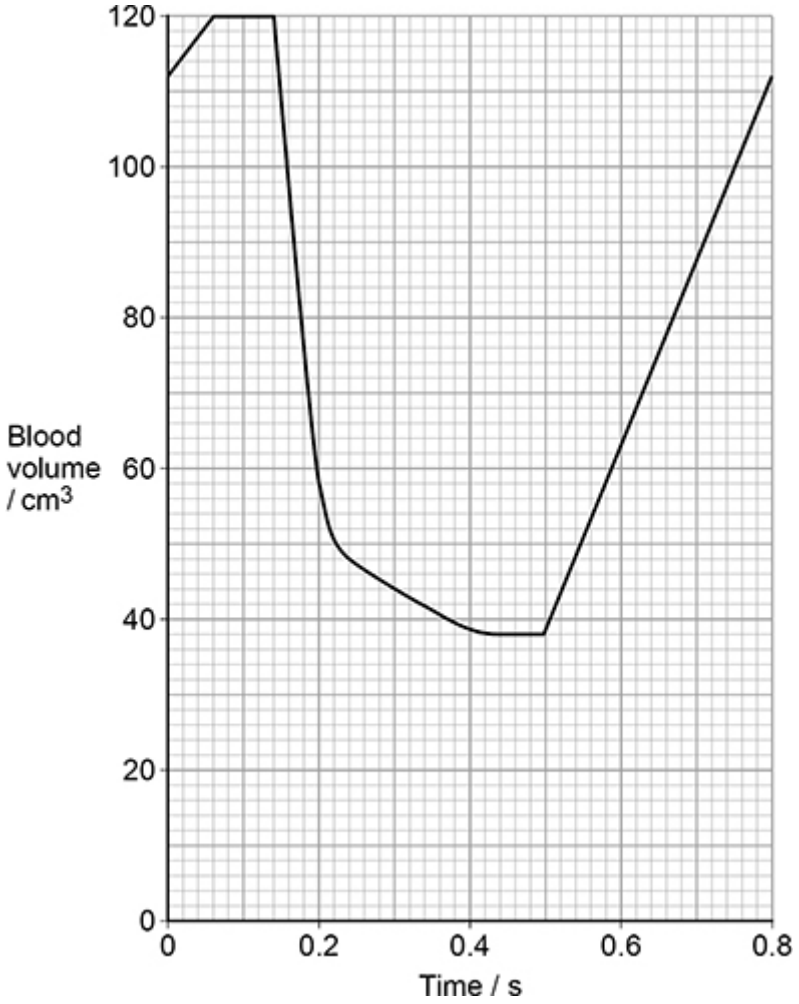
Complete the table below by giving **three** control measures the student must use to reduce the risks associated with carrying **and** using a scalpel.

Source	Hazard	Control measures to reduce risk
Sharp knife		1.
		2.
		3.

(2)

(b) A scientist measured the changes in blood volume inside the left ventricle of a mammalian heart during one heartbeat. **Figure 1** shows her results.

Figure 1



Use **Figure 1** to calculate the total volume of blood pumped from the left ventricle in 1 minute.

Answer _____ cm^3

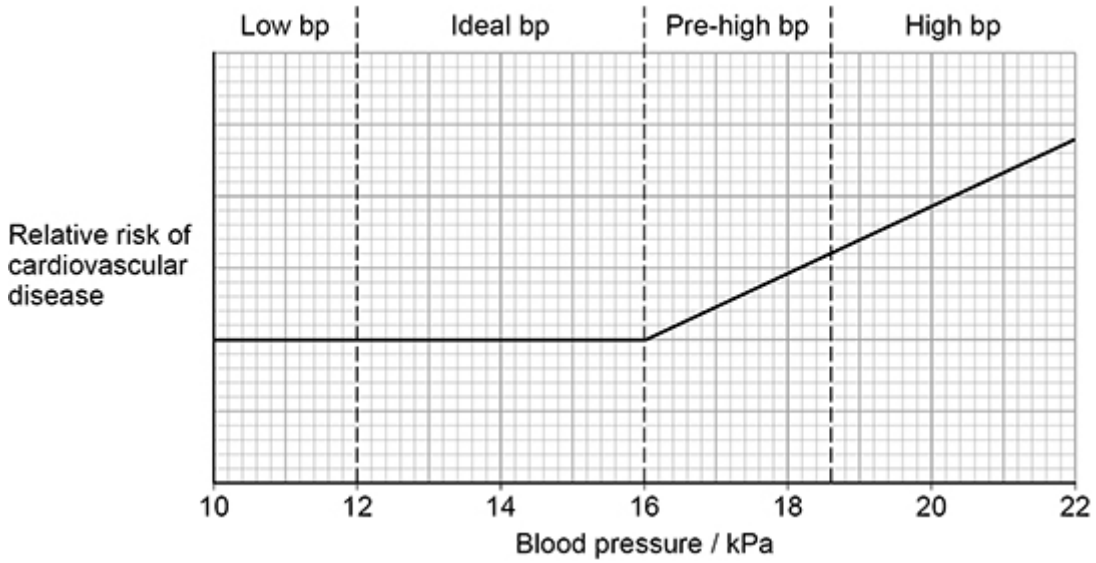
(2)

Scientists investigated the correlation between patients' blood pressure (bp) and the risk of these patients developing cardiovascular disease.

They grouped the blood pressure measurements into four health categories: low, ideal, pre-high and high blood pressure.

Figure 2 shows the scientists' results.

Figure 2



In a separate investigation, a doctor measured the effect of blood pressure medicines on treating a large number of patients with a mean blood pressure of 22 kPa

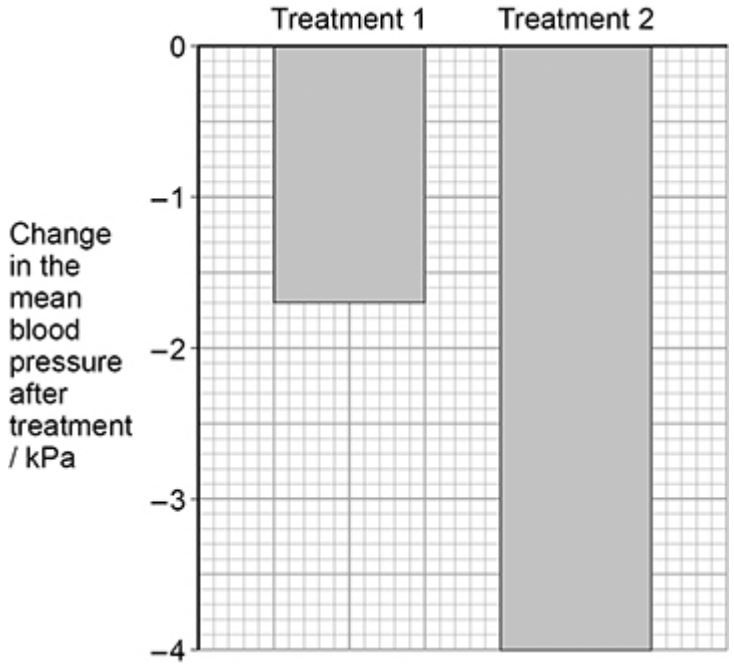
The doctor used two different treatments.

- Treatment 1 contained one blood pressure medicine.
- Treatment 2 contained three blood pressure medicines.

He measured the change in the mean blood pressure after each treatment in these patients.

Figure 3 shows his results.

Figure 3



(c) Using information in **Figure 2** and **Figure 3**, evaluate the effect of these treatments on reducing the risk of developing cardiovascular disease in patients with a mean blood pressure of 22 kPa

(4)

(Total 8 marks)

Q7.

Amino acids are used to make proteins. **Table 1** shows the R groups of six different amino acids.

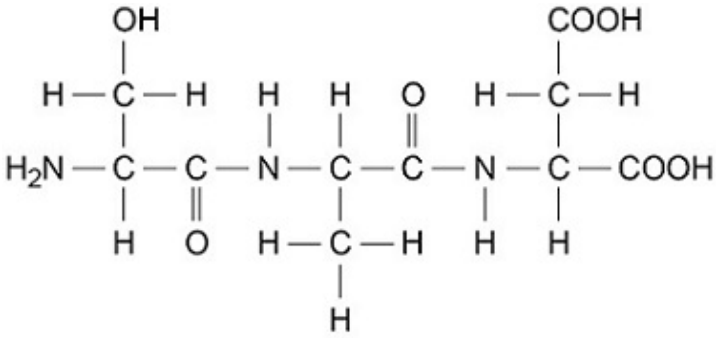
Table 1

Amino acid	R group
Alanine	CH_3
Asparagine	CH_2CONH_2
Aspartic acid	CH_2COOH

Amino acid	R group
Glutamic acid	CH_2CH_2COOH
Glycine	H
Serine	CH_2OH

(a) Use **Table 1** to identify the **three** different amino acids used to make the polypeptide shown in **Figure 1**.

Figure 1



Left amino acid _____

Middle amino acid _____

Right amino acid _____

(2)

(b) **Table 2** shows three statements and names of four biological molecules.

Put a Tick (✓) in each box where the statement is true for the biological molecule.

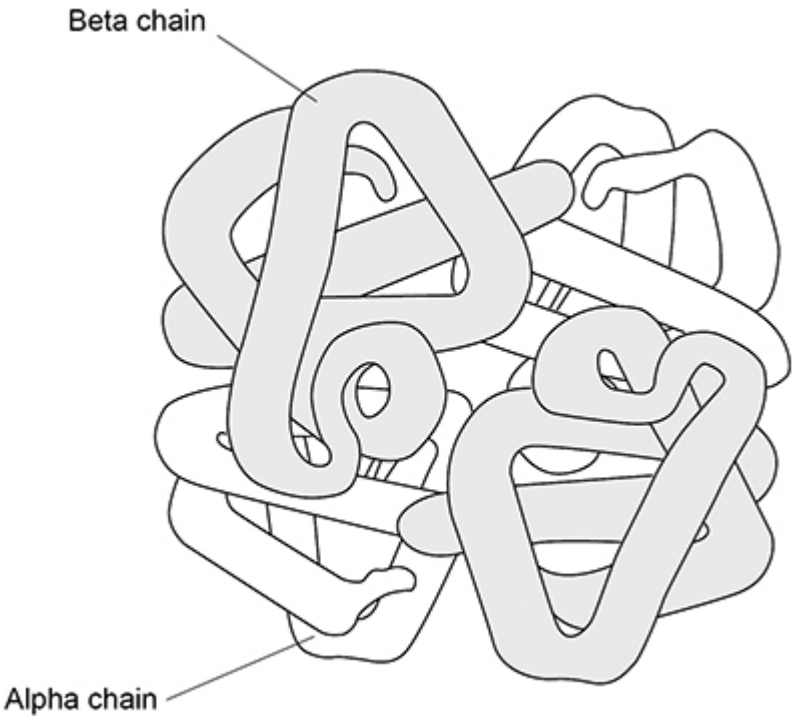
Table 2

Statement	DNA	ATP	Reverse transcriptase	Phospholipid
Contains peptide bonds				
Is formed using a condensation reaction				
Is a polymer				

(3)

Figure 2 represents the structure of adult human haemoglobin.

Figure 2



(c) The number of amino acids in the beta chains in **Figure 2** is 3.546% greater than in the alpha chains. Each alpha chain contains 141 amino acids.

Calculate how many amino acids there are in total in the haemoglobin molecule shown in **Figure 2**. Give your answer to the nearest whole number.

Answer _____ amino acids

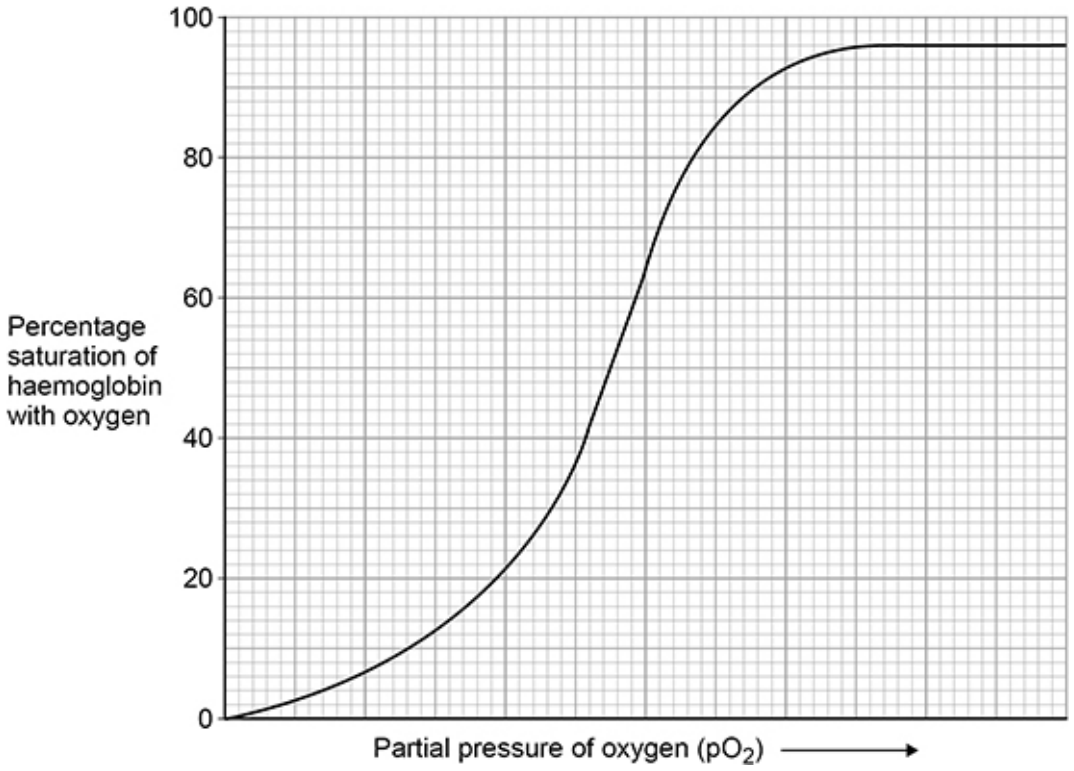
(2)

When a substance called BPG binds to haemoglobin, it reduces the affinity of haemoglobin for oxygen.

(d) **Figure 3** shows an oxyhaemoglobin dissociation curve for haemoglobin in normal conditions.

Sketch a curve on **Figure 3** to show the oxyhaemoglobin dissociation curve for haemoglobin when BPG binds to it.

Figure 3



(1)

(e) Suggest and explain when it would be an advantage to a human for BPG to bind to haemoglobin.

_____

_____

_____

_____

_____

_____

_____

(2)

(Total 10 marks)