Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
June 2002
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

BIOLOGY/HUMAN BIOLOGY (SPECIFICATION A) BYA1
Unit 1 Molecules, Cells and Systems

Monday 27 May 2002 Morning Session

No additional materials are required.
You may use a calculator.

Time allowed: 1 hour 30 minutes

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** the questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information

- The maximum mark for this paper is 75.
- Mark allocations are shown in brackets.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
7			
8			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

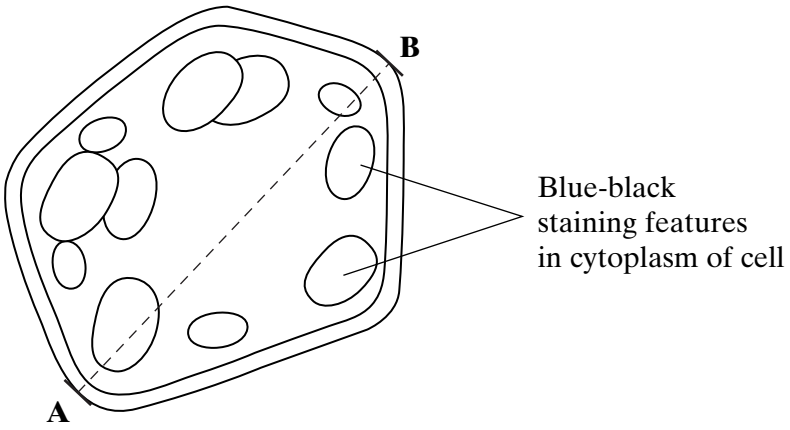
Answer **all** questions in the spaces provided.

1 (a) Complete the following table. Use a tick if the feature is present or a cross if it is absent.

Cell	Feature		
	Plasma membrane	**Nucleus**	**Cell wall**
Red blood cell			
Lymphocyte			
Photosynthesising cell from a leaf			
Bacterium			

(3 marks)

(b) Cells were scraped from the cut surface of a potato tuber. They were stained with iodine solution and examined with an optical microscope. The drawing shows one of these cells.



(i) Name **two** polysaccharides found in this cell which would not be found in a red blood cell.

1. .....

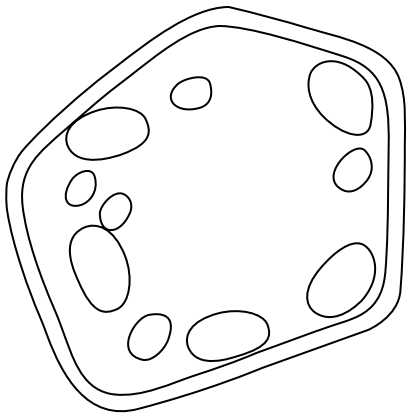
2. .....

(1 mark)

(ii) The diameter of this cell, measured from **A** to **B**, is 40 µm.
Calculate the magnification of the drawing. Show your working.

Answer .....
(2 marks)

(iii) The focusing knob of the microscope was adjusted slightly. The drawing below shows how the cell then looked.



Explain the difference in appearance of the cell contents.

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(2 marks)

8

2 (a) A protein is formed from 300 amino acids. The diagrams show the primary, secondary and tertiary structures of this protein.

Primary structure. Length = 300 nm

Secondary structure. Length = 45 nm

Tertiary structure. Length = 8.6 nm

(i) Explain what causes the secondary structure to differ in length from the primary structure.

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(1 mark)

(ii) Explain what is meant by the tertiary structure of a protein.

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(1 mark)

(iii) Heating may affect the tertiary structure of a protein. Explain how.

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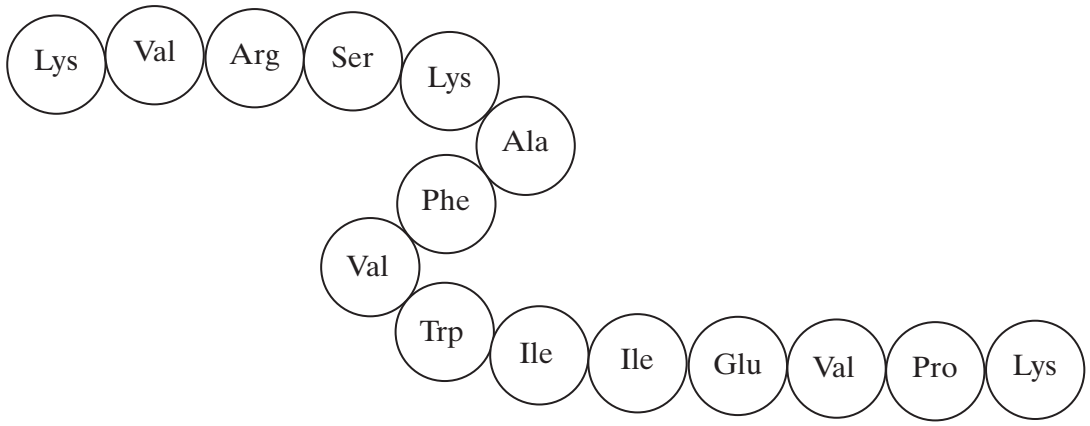
(2 marks)

(b) The first step in investigating the primary structure of a protein is to break it into shorter lengths with enzymes. The table shows some of the enzymes used and the position of the peptide bonds they break.

Enzyme	Position of peptide bond that enzyme breaks	
	First amino acid	Second amino acid
Trypsin	Lys or Arg	any
Chymotrypsin	Phe, Trp or Tyr	any
V8 protease	Glu	any

The diagram shows a polypeptide chain. The sequence of amino acids should be read from left to right.



(i) How many amino acid fragments will be produced from this polypeptide if it is incubated with a mixture of trypsin and V8 protease?

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(1 mark)

(ii) Explain why trypsin and chymotrypsin break peptide bonds between different amino acids.

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(3 marks)

8

Turn over ▶

3 (a) Describe how phospholipid molecules are arranged in a plasma membrane.

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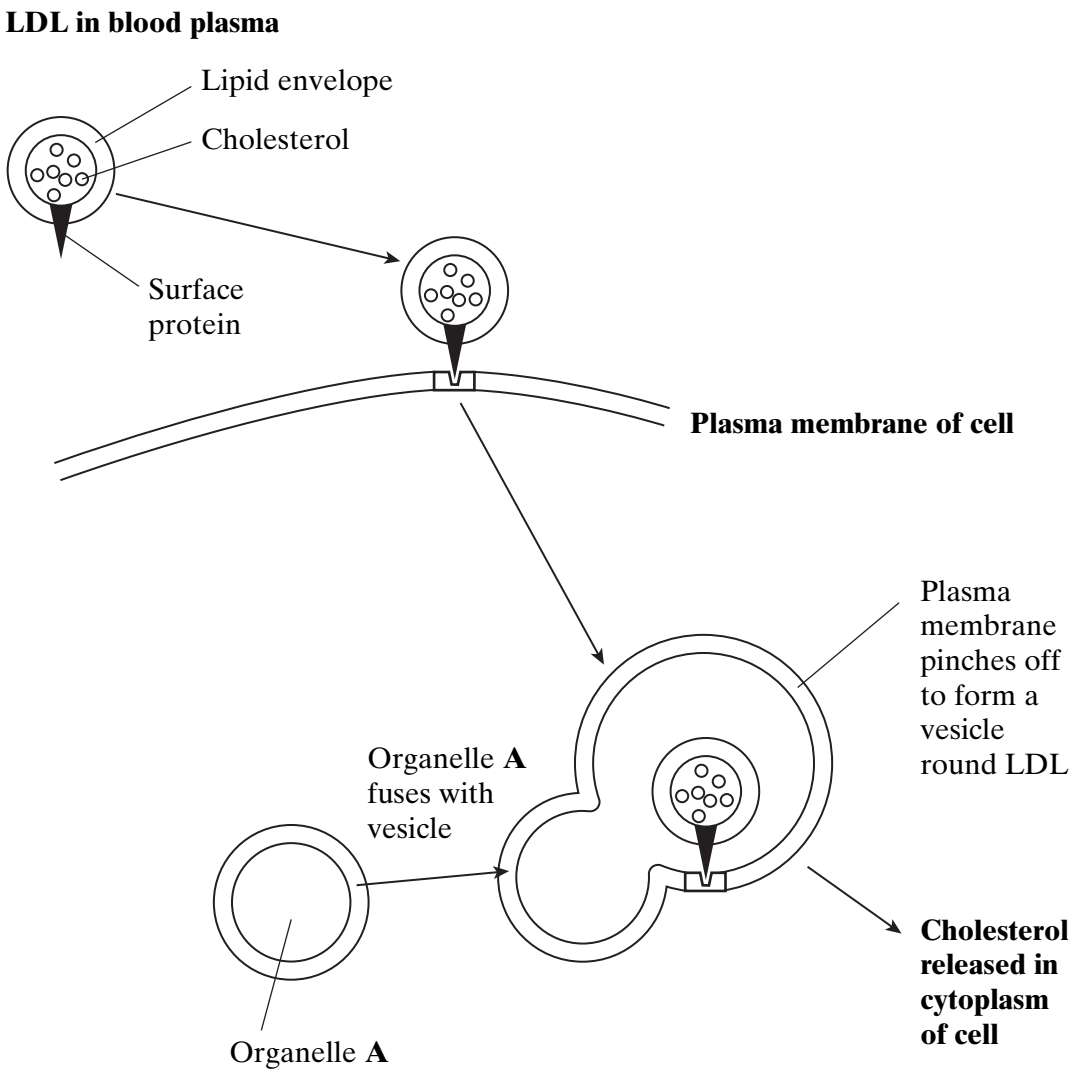
(2 marks)

Cholesterol is a substance needed in human cells. It is carried in the blood in a particle called a low-density lipoprotein (LDL). The diagram shows how an LDL is taken into a cell and how the cholesterol it contains is released in the cytoplasm.



(b) Suggest why an LDL will only attach to certain areas on the plasma membrane of a cell.

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(1 mark)

(c) Name the process by which the LDL enters the cell.

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(1 mark)

(d) (i) Name organelle **A**.

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(1 mark)

(ii) Explain how this organelle is involved in the release of cholesterol from the vesicle.

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(2 marks)

7

TURN OVER FOR THE NEXT QUESTION

4 Fick's law shows how some factors affect the rate of diffusion.

$$\text{Rate of diffusion is proportional to } \frac{\text{surface area} \times \text{difference in concentration}}{\text{thickness of exchange surface}}$$

(a) Describe **one** adaptation of the alveolar epithelium which allows efficient diffusion.

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(1 mark)

(b) Emphysema is a condition in which the walls between the alveoli break down and enlarge the air spaces. The blood of a person with emphysema contains a higher concentration of carbon dioxide than the blood of a healthy person. Use Fick's law to explain why.

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(2 marks)

(c) The table shows some measurements made on people living at two different altitudes.

Altitude/m	**Concentration of oxygen in blood in arteries/ cm^3 per 100 cm^3**	**Number of red blood cells in 1 mm^3 of blood**
150	18.3	5.3×10^6
3700	19.9	5.9×10^6

(i) The concentration of oxygen in the blood in the arteries of people living at 3700 m is higher than in the arteries of people living at 150 m. Use the information in the table to explain why.

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(2 marks)

(ii) People who move from low to high altitude are often breathless at first. Suggest why this breathlessness disappears after living at high altitude for several weeks.

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(2 marks)

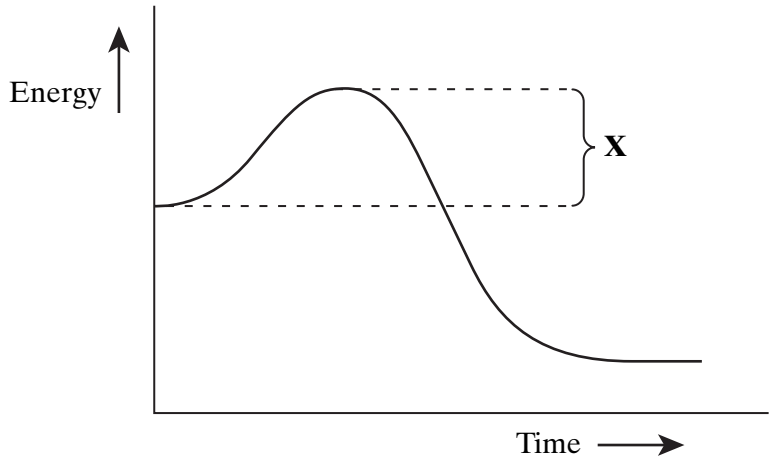
7

TURN OVER FOR THE NEXT QUESTION

5 (a) When heated, hydrogen peroxide breaks down to water and oxygen.

$$2H_2O_2 \longrightarrow 2H_2O + O_2$$

The graph shows the energy changes which take place during this reaction.



(i) What is represented by the part of the curve labelled **X**?

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(1 mark)

(ii) This reaction also takes place in many living cells. Here it is catalysed by the enzyme catalase. Sketch a curve on the graph to show the energy changes which take place when the enzyme is present. *(2 marks)*

(iii) When the reaction with catalase is carried out in a test-tube, the test-tube feels warm at the end of the reaction. Use the graph to explain why.

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(2 marks)

(b) The turnover number of an enzyme is the number of substrate molecules converted to product per second. The maximum turnover number of catalase is 200 000 molecules per second. Explain why the turnover number falls as the temperature gets lower.

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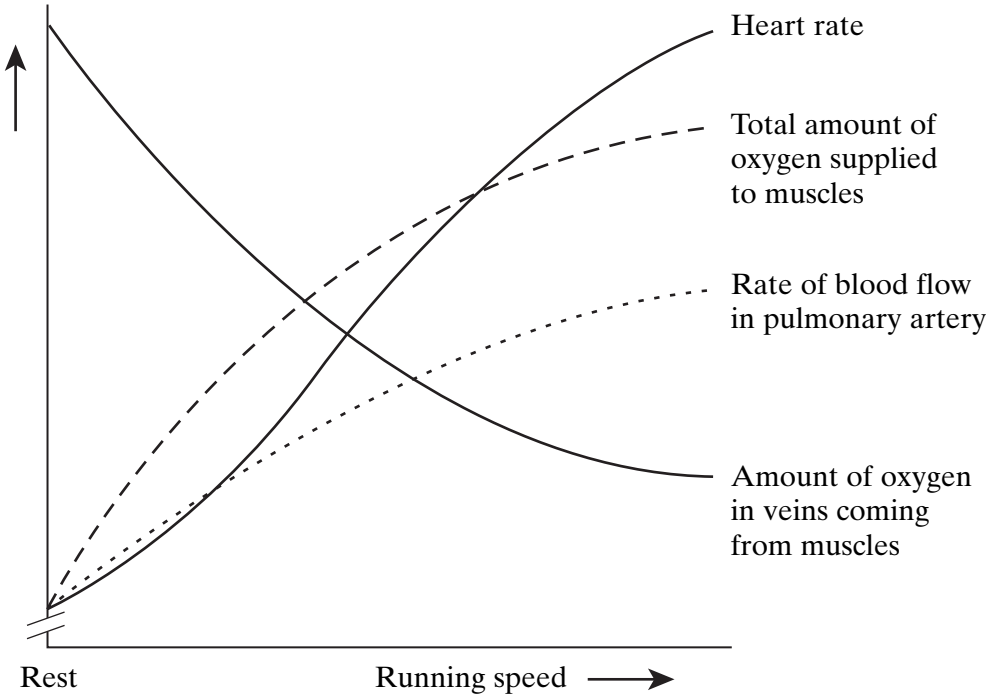
(2 marks)

7

TURN OVER FOR THE NEXT QUESTION

6 An athlete ran at different speeds on a treadmill. The graph shows some of the changes which occurred as running speed increased.



(a) (i) Give suitable units for the rate of blood flow in the pulmonary artery.

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(1 mark)

(ii) Explain why the rate of blood flow in the pulmonary artery changes when the heart rate changes.

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(1 mark)

(b) Describe how nerves going to the heart can increase heart rate.

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(3 marks)

(c) During exercise, red blood cells give up more of the oxygen they are transporting. Give **one** piece of evidence from the graph which supports this statement.

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(1 mark)

(d) Suggest how an increase in the rate of blood flow in the pulmonary artery helps to supply more oxygen to muscles.

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(2 marks)

8

TURN OVER FOR THE NEXT QUESTION

7 Read the following passage.

If you read a sports magazine, it will not be long before you come across an advert for a sports drink. These adverts often claim that performance can be improved by consuming such drinks. Is this just a sales gimmick or is there a scientific basis for these claims?

Most sports drinks have a similar composition. Apart from water, the main ingredient is carbohydrate. This is usually a mixture of different sugars – sucrose and the two monomers from which it is formed by condensation – glucose and fructose. This combination improves taste and ensures efficient water absorption from the intestine. Most commercially available drinks are advertised as isotonic. They have the same water potential as the body fluids. When sugars are transported into the cells lining the intestine, water will also be absorbed.

Recently there has been an interest in the addition of particular amino acids to these drinks. Glutamine has been added because it is supposed to help protect the body from minor illness and infection. As well as glutamine, amino acids with a branched R-group may be added. These appear to be linked with the delay of biochemical processes in the body which cause fatigue.

Use the information from the passage and your own knowledge to answer the questions.

(a) Glucose and fructose both have the same molecular formula, $C_6H_{12}O_6$.

(i) Suggest how two molecules can have the same formula but a different structure.

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(1 mark)

(ii) What is the molecular formula of a molecule of sucrose?

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(2 marks)

(b) (i) The uptake of sugars from the intestine involves facilitated diffusion and active transport. Give **two** ways in which facilitated diffusion differs from active transport.

1 .....

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2 .....

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(2 marks)

(ii) Explain how transport of sugars into cells lining the intestine (lines 8-9) leads to water being absorbed.

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(2 marks)

(c) Give **two** ways in which the structure of a glutamine molecule (line11) is identical to the structure of an amino acid with a branched R-group (line 12).

1 .....

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2 .....

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(2 marks)

(d) Describe how you would use chromatography to separate and identify the different sugars in a sports drink.

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(6 marks)

8 (a) During the cardiac cycle the heart fills with blood and then the ventricles contract. The table gives the filling time and the contraction time at different heart rates.

Heart rate/beats per minute	Filling time/seconds	Contraction time/seconds
39.7	0.37	1.14
49.6	0.38	0.83
71.4	0.38	0.46
81.1	0.38	0.36
87.0	0.39	0.30

(i) Give **two** conclusions that can be drawn from the figures in the table.

1 .....

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2 .....

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(2 marks)

(ii) Explain how you would use the figures in the table to calculate the contraction time at a heart rate of 60 beats per minute.

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(2 marks)

(iii) What additional information would you need in order to find the cardiac output at a particular heart rate?

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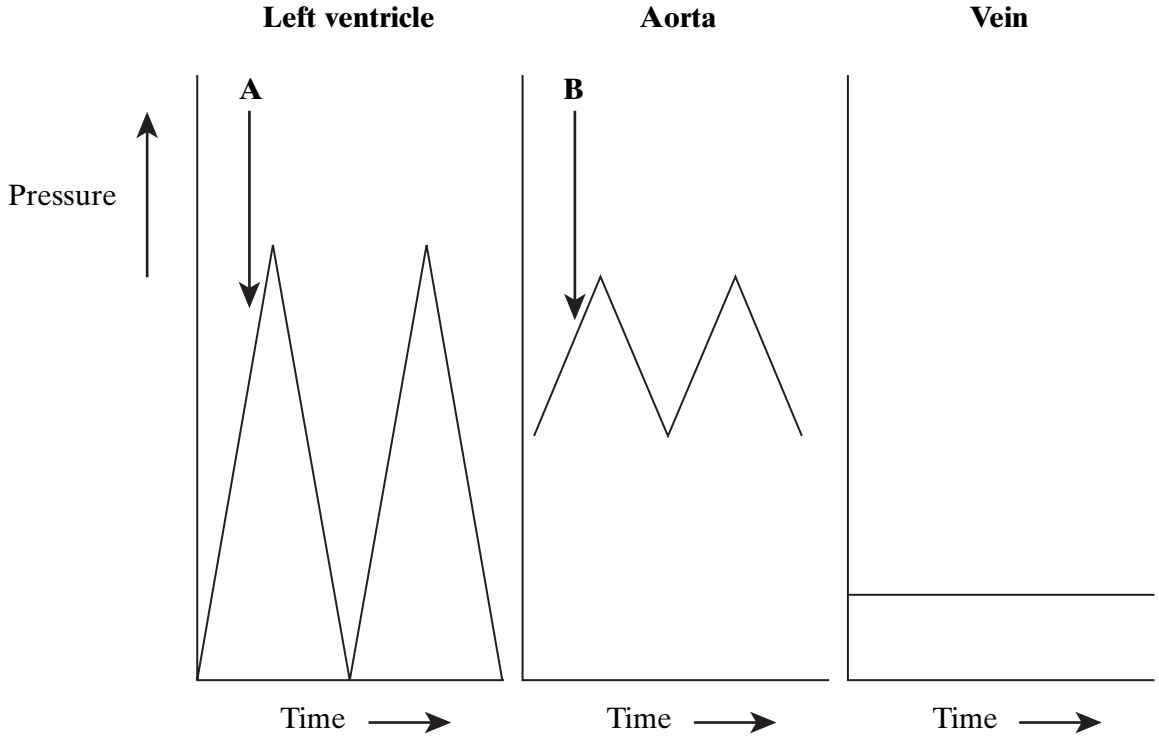
(1 mark)

(b) The diagram shows variations in blood pressure in different parts of the circulatory system.



(i) Complete the table with ticks to show whether each of the valves is open or closed at the point indicated with the letter **A** on the diagram.

Valve located between	Open	Closed
left atrium and left ventricle		
left ventricle and aorta		
right atrium and right ventricle		
right ventricle and pulmonary artery		

(2 marks)

(ii) A pulse can be felt when the fingers are placed over an artery that is close to the surface. Explain why a pulse cannot be felt when the fingers are placed over a vein which is close to the surface.

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(1 mark)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(iii) What causes the blood pressure to increase at the point indicated with a letter **B** on the diagram?

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(1 mark)

(c) Explain how tissue fluid is formed and returned to the circulatory system.

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(6 marks)

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END OF QUESTIONS