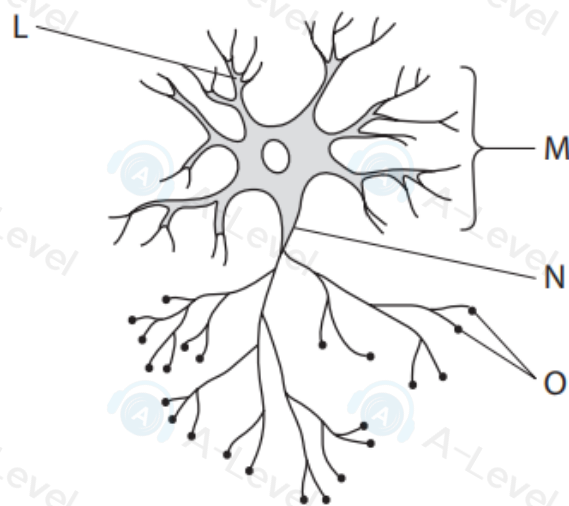


3 The diagram shows a relay neurone.



(a) (i) Complete the table by filling in the names of each labelled part.

(2)

| Label | Part |
|-------|------|
| L     |      |
| M     |      |
| N     |      |
| O     |      |

(ii) Lidocaine is a drug that is used as a local anaesthetic.

Lidocaine works by

(1)

- ☒ **A** blocking the binding of acetylcholine to its receptor
- ☒ **B** blocking the release of acetylcholine
- ☒ **C** inhibiting potassium ion channels
- ☒ **D** inhibiting sodium ion channels

**5:** When an organism grows or increases in number, cell division takes place.

(a) When a cell is preparing to divide, DNA synthesis takes place.

Explain how two identical molecules of DNA are produced.

(2)

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(b) Protein synthesis increases as a cell grows.

Describe the roles of messenger RNA (mRNA) and transfer RNA (tRNA) in protein synthesis.

(3)

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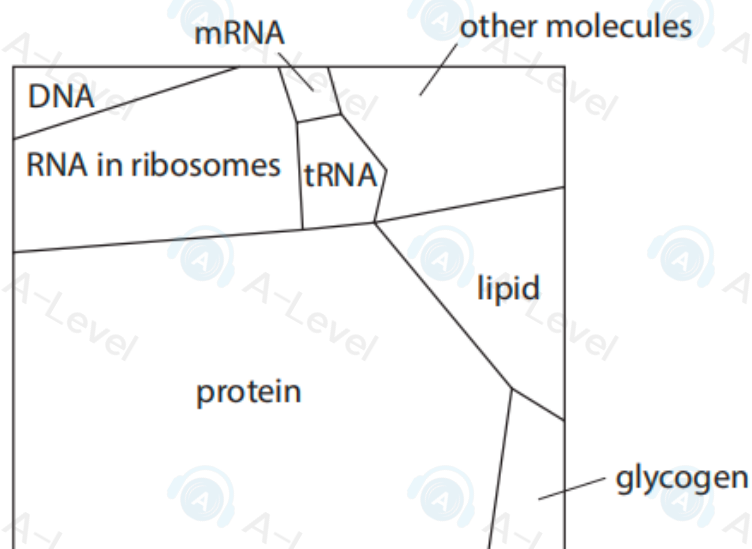
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(c) The Voronoi diagram shows the proportions of molecules in a bacterial cell.

The area of each labelled part of the square is proportional to the percentage of the dry mass of that molecule. The shape of each part has no meaning.



(Source: <http://book.bionumbers.org/what-is-the-macromolecular-composition-of-the-cell/>)

(i) Give **one** advantage and **one** disadvantage of using a Voronoi diagram to present this information.

(2)

Advantage

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Disadvantage

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- \*(ii) The proportions of these molecules change as a bacterial cell prepares to divide, as it divides into two new bacterial cells and as each new bacterial cell grows.

Discuss how the appearance of this Voronoi diagram might change:

- as a bacterial cell prepares to divide
- in one of the new bacterial cells produced
- as one new bacterial cell increases in size.

Give reasons for these changes to support your answer.

(6)

(Total for Question 5 = 13 marks)

**5** People with cystic fibrosis produce very thick, sticky mucus.

Cystic fibrosis is caused by mutations in a gene coding for the CFTR protein.

(a) Explain why a mutation in this gene results in the production of very thick, sticky mucus.

(3)

[illegible]

A diagram of a female torso showing internal organs. Three labels with lines pointing to specific organs are present: 'breathing difficulties' points to the lungs, 'problems absorbing nutrients' points to the stomach, and 'infertility' points to the reproductive system.

(5)

The graph shows the relationship between the level of function of the CFTR protein (x-axis) and the concentration of chloride ions in sweat (y-axis). The x-axis is labeled 'Level of function of the CFTR protein (%)' and ranges from 0 to 100. The y-axis is labeled 'Concentration of chloride ions in sweat / mmol dm<sup>-3</sup>' and ranges from 0 to 100. The curve shows that as the level of function of the CFTR protein decreases, the concentration of chloride ions in sweat increases. The curve starts at (100, 20) and ends at (0, 100).

| Level of function of the CFTR protein (%) | Concentration of chloride ions in sweat / mmol dm <sup>-3</sup> |
|-------------------------------------------|-----------------------------------------------------------------|
| 100                                       | 20                                                              |
| 50                                        | 25                                                              |
| 20                                        | 60                                                              |
| 10                                        | 75                                                              |
| 0                                         | 100                                                             |

(i) Which is the change in concentration of chloride ions in the sweat of an individual when the level of function of CFTR protein decreased from 100% to 18%?

☐ A 15 mmol dm<sup>-3</sup>

☐ B 35 mmol dm<sup>-3</sup>

☐ C 40 mmol dm<sup>-3</sup>

☐ D 80 mmol dm<sup>-3</sup>

(ii) Cystic fibrosis results from different mutations in the CFTR gene.

Explain how the graph provides evidence that cystic fibrosis results from different mutations in the CFTR gene.

(2)

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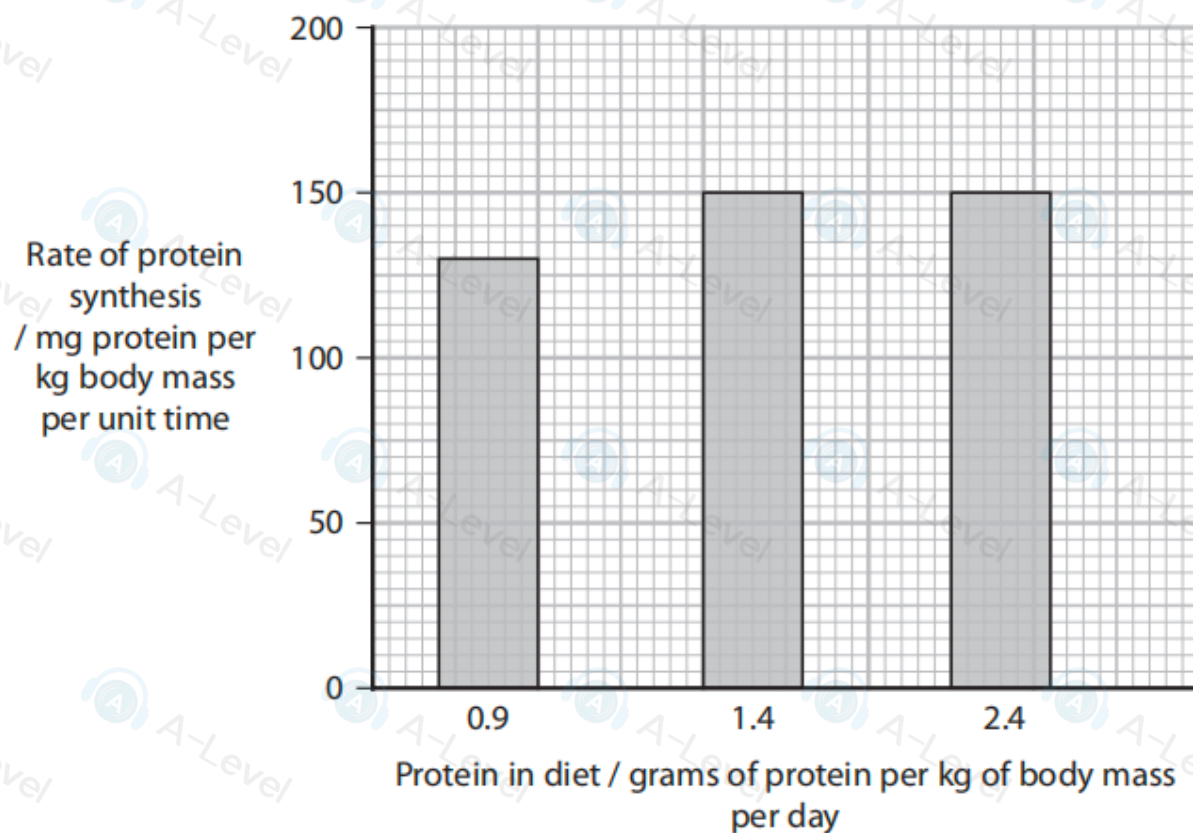
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**(Total for Question 5 = 11 marks)**

3 Amino acids in the diet of animals are used to synthesise proteins.

(a) The rate of protein synthesis is dependent on a number of factors.

The graph shows the effect of the mass of protein in the diet on the rate of protein synthesis.



Calculate the minimum mass of protein a person with a mass of 70kg should eat in one week if they want a rate of protein synthesis of 150 mg protein per kg body mass per unit time.

(2)

Answer \_\_\_\_\_

(b) (i) Name the **two** stages in protein synthesis, in the order that they occur.

(1)

Stage 1

Stage 2

(ii) Describe the roles of messenger RNA (mRNA) and transfer RNA (tRNA) in protein synthesis.

(4)

**(Total for Question 3 = 7 marks)**

**8:** Gum disease affects up to 90% of the world's adult population.

Gum disease has been shown to be associated with the development of cardiovascular disease (CVD).

(a) Towards the end of 2023, the world's population was 8 078 799 080.

Approximately 70% of this population were adults.

Estimate the number of adults in the world.

Give your answer in standard form.

(2)

Answer .....

(b) The development of gum disease can be reduced by good oral hygiene.

This is one example of a healthy lifestyle.

Give **two** other examples of a healthy lifestyle that can help reduce the risk of CVD.

(1)

1 .....

2 .....

(c) Gum disease is caused by inflammation.

Chemicals released into the blood as a result of the inflammation are thought to cause damage to the circulatory system.

The number of white blood cells present in the saliva increases in the early stages of gum disease.

In a study, Canadian scientists determined the correlation between the number of neutrophils in saliva and damage to the circulatory system.

Neutrophils are a type of white blood cell.

The scientists took samples of saliva from volunteers in the study, determined the blood pressure in their arteries and assessed the damage to their endothelial cells.

(i) Give the meaning of the term **correlation**.

(1)

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(ii) It was important that all the people in the study had similar blood pressure that was within a healthy range.

Explain why this was important.

(3)

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(iii) Calculate the blood pressure of a person who has a systolic blood pressure (SBP) of 11.0kPa and a diastolic blood pressure (DBP) of 6.7 kPa, using the formula:

$$\text{blood pressure} = \frac{\text{SBP} + (2 \times \text{DBP})}{3}$$

(1)

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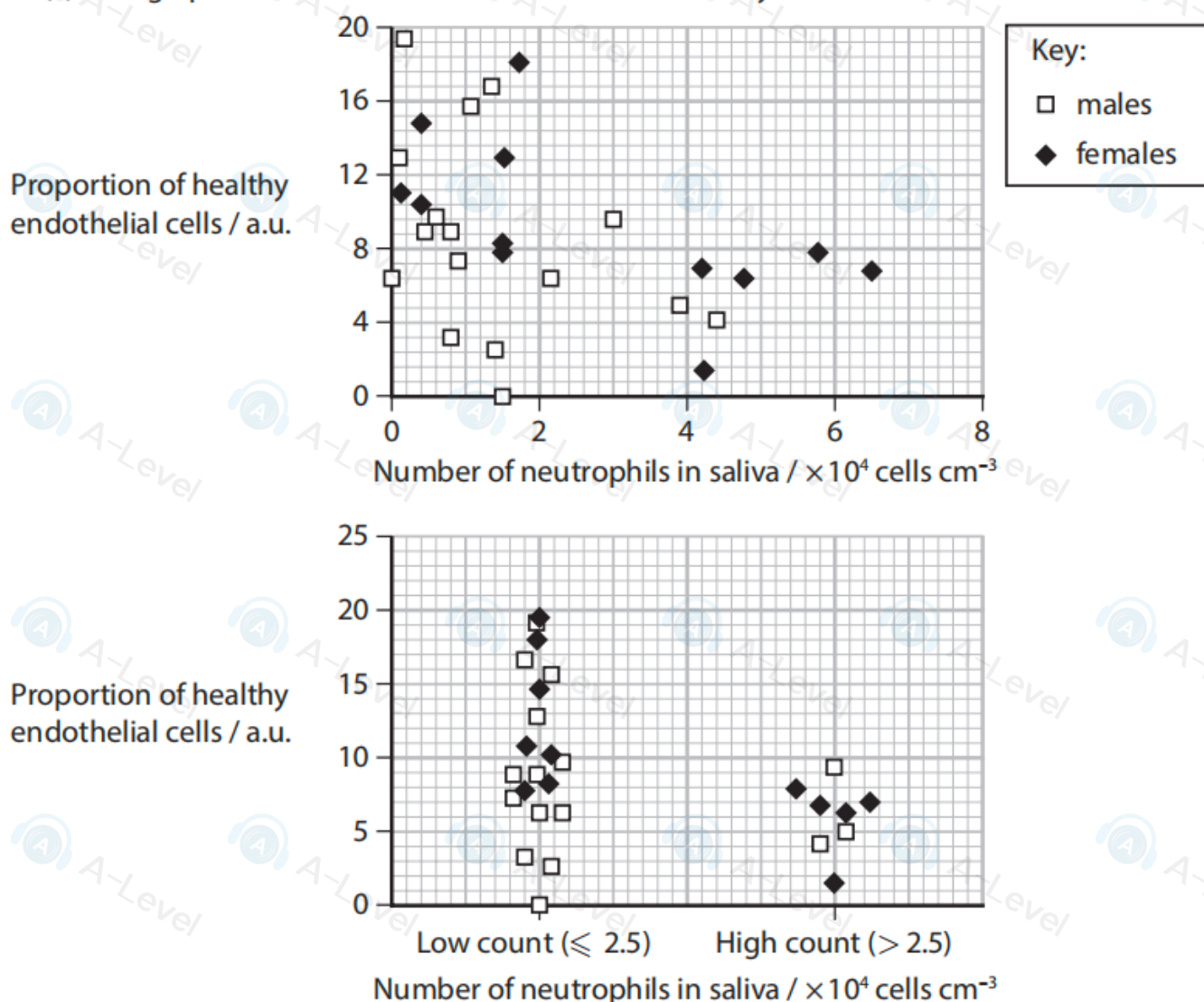
Answer ..... kPa

(iv) The scientists assessed the damage to endothelial cells.

Explain why damage to endothelial cells might be an indication that a person is at risk of CVD.

(3)

(v) The graphs show some of the results from this study.



Comment on the relationships between the number of neutrophils and the proportion of healthy endothelial cells of the males and females in this study.

(4)

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**(Total for Question 8 = 15 marks)**

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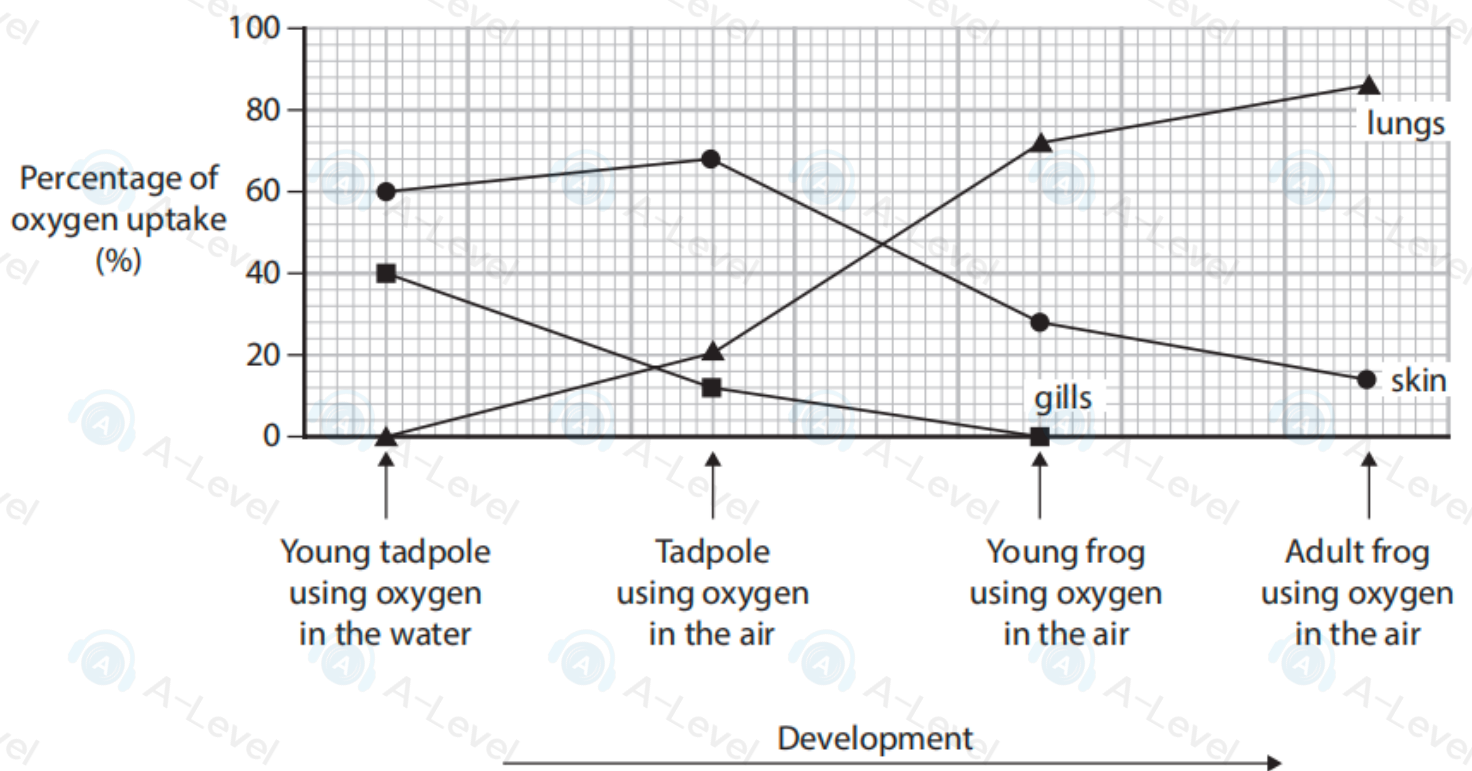
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**TOTAL FOR PAPER = 80 MARKS**

4: One function of the heart is to transport oxygen from the gas exchange surface to the cells.

(a) The gas exchange surfaces of a frog change as a tadpole develops into an adult frog.

The graph shows some of these changes.



The contribution to gas exchange of the lungs, gills and skin changes as a tadpole develops into a frog.

Explain the importance of these changes.

(3)

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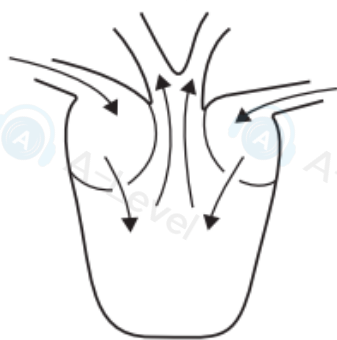
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(b) The diagram shows the structure of the heart of a frog.



Give **one** similarity and **one** difference between the structure of this heart and a mammalian heart.

(2)

Similarity

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Difference

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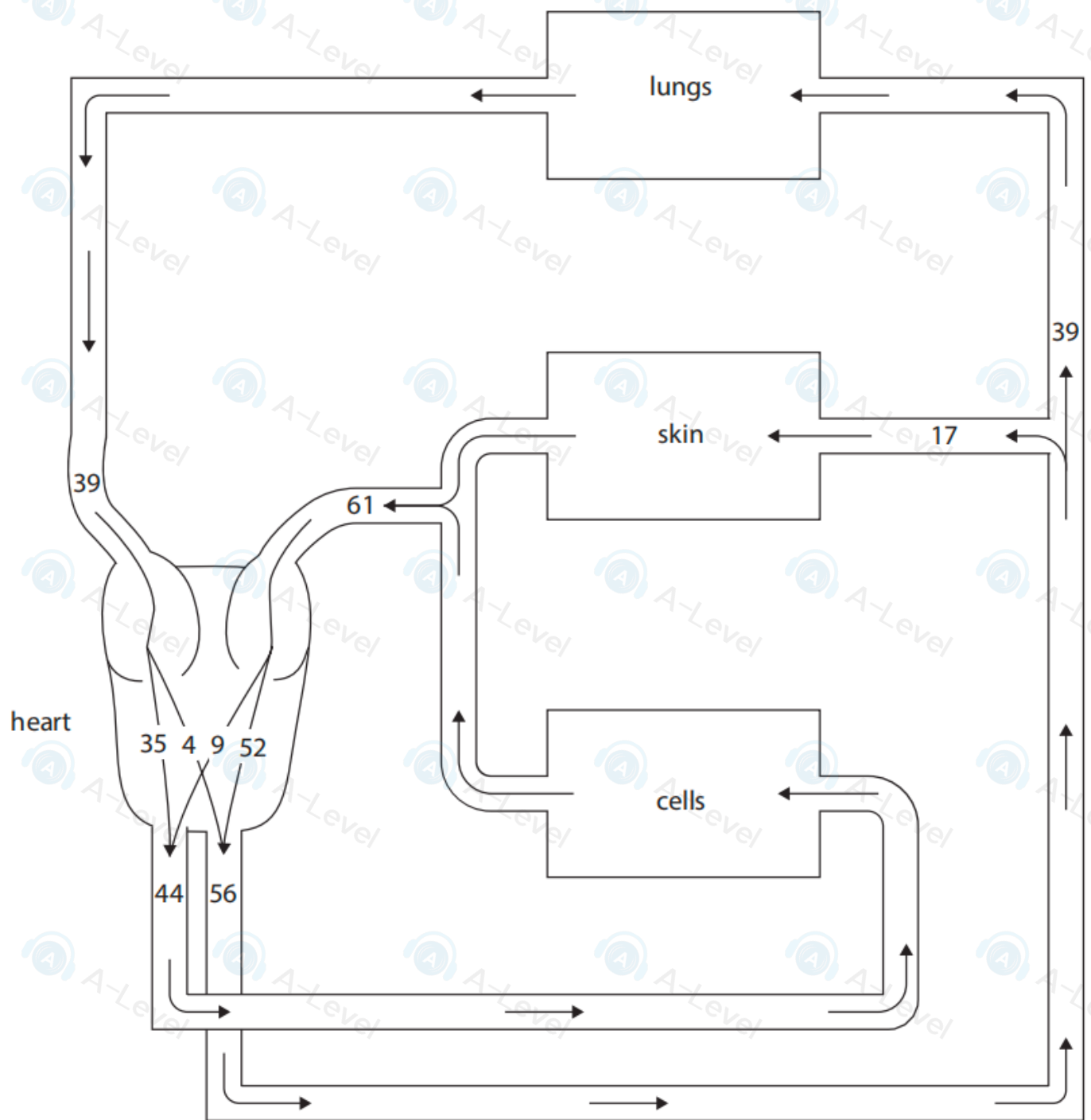
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\*(c) The diagram shows the distribution of blood flowing through the circulatory system of a frog.

The percentages of blood flowing through the parts of the circulatory system are shown on the diagram.



The cells of the frog need oxygen to survive.

Explain how the circulatory system and the gas exchange surfaces of an adult frog are able to meet this need for oxygen.

Use the information in the diagram to support your answer.

(6)

**(Total for Question 4 = 11 marks)**

2 *Daphnia* are small invertebrates that live in ponds and lakes.

The photograph below shows a *Daphnia*.



Magnification  $\times 25$

A student investigated the effect of temperature on the heart rate of *Daphnia*.

The table below shows the results of this investigation.

| Temperature / $^{\circ}\text{C}$ | Heart rate / beats $\text{min}^{-1}$ |
|----------------------------------|--------------------------------------|
| 10                               | 78                                   |
| 15                               | 82                                   |
| 20                               | 96                                   |
| 25                               | 150                                  |
| 30                               | 178                                  |

(4)

(2)

2)

**(Total for Question 2 = 8 marks)**

- (i) Put a cross ☒ in the box that shows the correct orientation of rod cells to photons of light hitting the retina.

(1)

☒ A

☒ B

☒ C

☒ D

- (ii) Put a cross ☒ in the box that describes what happens to rhodopsin when photons of light enter rod cells.

(1)

☒ A rhodopsin is bleached producing opsin and cis-retinal

☒ B rhodopsin is bleached producing opsin and trans-retinal

☒ C rhodopsin is formed from opsin and cis-retinal

☒ D rhodopsin is formed from opsin and trans-retinal