Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____
I declare this is my own work.

A-level
BIOLOGY

Paper 1

Time allowed: 2 hours

Materials
For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 91.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

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ANSWER IN THE SPACES PROVIDED

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

0 1 . 1 Describe the structure and function of the nucleus.

[4 marks]

Question 1 continues on the next page

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0 1 . 2 Name the main polymer that forms the following cell walls.

[1 mark]

Plant cell wall _____

Fungal cell wall _____

Scientists investigated the effect of the number of fungal species in soil on the diversity of plant species.

Table 1 shows their raw data for soil containing 14 fungal species.

Table 1

Plant species	**Total shoot biomass / g m^{-2}**
Poa compressa	2
Achillea millefolium	4
Aster cordifolius	5
Aster novae-angliae	7
Chrysanthemum leucanthemum	15
Daucus carota	36
Fragaria virginiana	51

0 1 . 3 Suggest **one** reason the scientists used biomass instead of the number of individuals of each plant species when collecting data to measure diversity.

[1 mark]

_____

_____

_____

_____

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0 1 . 4 The scientists used this equation to calculate the plant species index of diversity.

$$d = 1 - \sum \left(\frac{n}{N}\right)^2$$

where n = shoot biomass of each plant species
and N = total shoot biomass of all plant species

Use this equation to calculate the index of diversity for the data in **Table 1**.

[2 marks]

Index of diversity _____

Question 1 continues on the next page

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Figure 1 shows the plant species index of diversity the scientists calculated when the soil contained 0, 1, 2, 4 and 8 fungal species.

Figure 1

Figure 1 not reproduced here due to third-party copyright restrictions

0 1 . 5 Sometimes farmers stop growing crops on an area of land to allow the natural ecosystem to recover. The plant species index of diversity of these areas previously used to grow crops is different from nearby land that has never been used to grow crops.

Suggest and explain how the plant species index of diversity would be different in these areas previously used to grow crops.

Use **Figure 1** and your knowledge of the effect of farming on biodiversity in your answer.

[2 marks]

_____

_____

_____

_____

_____

_____

10

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0 2 . 1 *Clostridium difficile* is a bacterial species that causes disease in humans.

Antibiotic-resistant strains of *C. difficile* have become a common cause of infection acquired when in hospital.

Explain how the use of antibiotics has led to antibiotic-resistant strains of bacteria becoming a common cause of infection acquired when in hospital.

[3 marks]

0 2 . 2 Scientists suggested that factors, other than antibiotic use, led to the increase in antibiotic-resistant *C. difficile* infections. One suggested factor is people eating more trehalose in their diet.

Trehalose is a disaccharide formed from two glucose molecules.

Name another disaccharide formed from two glucose molecules.

[1 mark]

Question 2 continues on the next page

Do not write outside the box

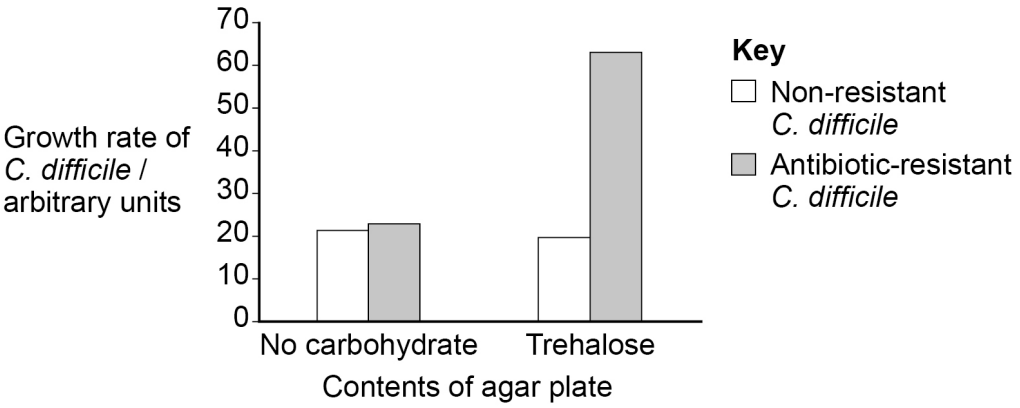
Scientists investigated the effect of trehalose on the growth rate of *C. difficile*.
They grew populations of non-resistant and antibiotic-resistant *C. difficile* on separate agar plates with:

- no carbohydrate added
- trehalose added.

They measured the growth rate of the *C. difficile*.

Figure 2 shows the scientists' results.

Figure 2



0 2 . 3 Describe how the scientists could use aseptic techniques to transfer 0.3 cm^3 of *C. difficile* in liquid culture from a bottle onto an agar plate.

[3 marks]

Do not write outside the box

0 2 . 4 Use **Figure 2** to evaluate whether more trehalose in the diet could be a factor in the increased number of antibiotic-resistant *C. difficile* infections.

[3 marks]

10

Turn over for the next question

Do not write outside the box

0 3 . 1 Give **two** features of **all** prokaryotic cells that are **not** features of eukaryotic cells.

[1 mark]

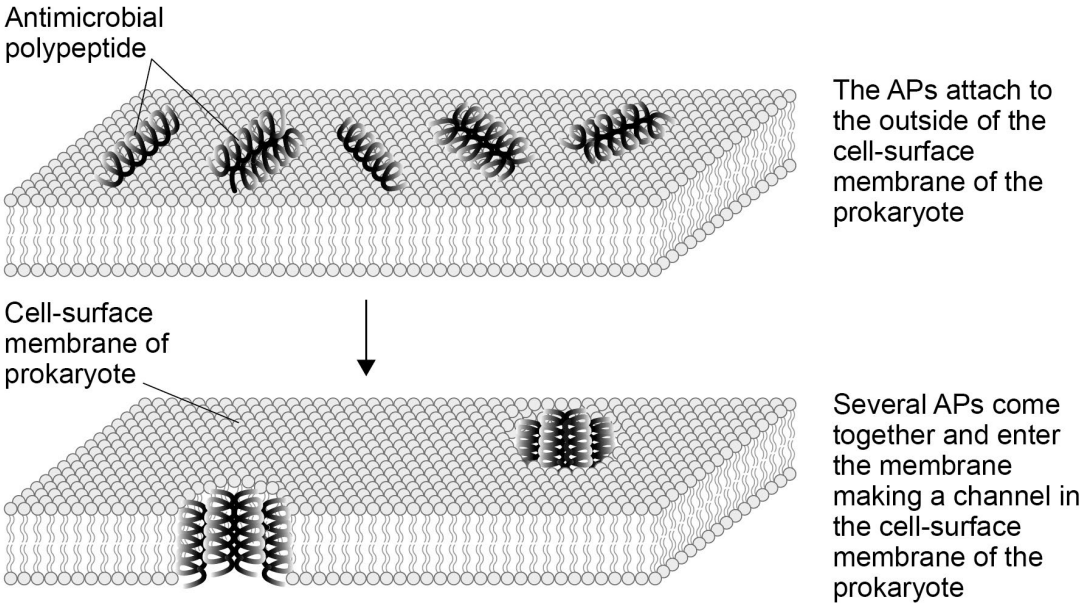
1 _____

2 _____

Many multicellular organisms produce antimicrobial polypeptides (APs) that protect them against prokaryotes.

Figure 3 shows how one type of AP acts on the cell-surface membrane of prokaryotes.

Figure 3



0 3 . 2 This AP has a secondary structure in a helical shape.

Tick (✓) the box to show which type of bond maintains the helical structure of the polypeptide.

[1 mark]

Disulfide ☐

Hydrogen ☐

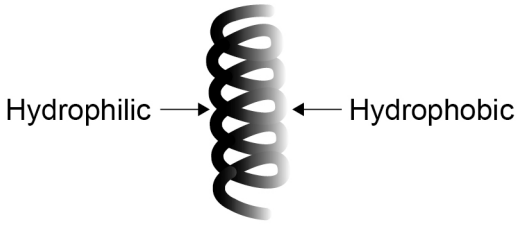
Ionic ☐

Peptide ☐

Do not write outside the box

0 3 . 3 The amino acids on one side of each AP helix have hydrophobic properties. The amino acids on the opposite side of each helix have hydrophilic properties. **Figure 4** shows this.

Figure 4



Suggest how these properties of the APs allow them to become positioned across the membrane (as shown in **Figure 3**) and make a channel through which ions can pass.

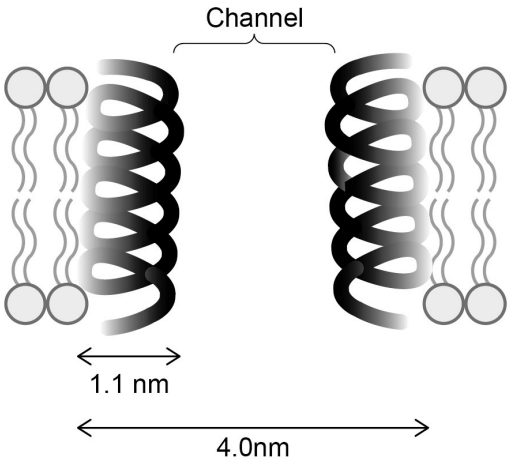
[2 marks]

Question 3 continues on the next page

Do not write outside the box

Figure 5 shows further information about a channel formed in the cell-surface membrane by the APs.

Figure 5



0 3 . 4 Use **Figure 5** to calculate the cross-sectional area of the channel through which ions can pass.
Assume the cross-sectional area is circular.
Use π = 3.14 in your calculation. Give your answer in nm^2 **and** to 1 decimal place.

[2 marks]

Answer _____ nm^2

Do not write outside the box

0 3 . 5 The APs damage prokaryotic cells but do not damage the eukaryotic cells in the organisms that produce them.
Prokaryotic cell membranes do not contain cholesterol.

Assess why the APs do not damage the eukaryotic cells of the organisms that produce them.

[2 marks]

0 3 . 6 Scientists observed these APs on prokaryotes using a transmission electron microscope. They stained the APs using a monoclonal antibody with gold attached to it.

Suggest how these techniques allowed observation of APs on prokaryotes.

[3 marks]

11

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0 4 . 1 Describe viral replication.

[3 marks]

0 4 . 2 Complete **Table 2** by putting a tick (✓) where the feature is part of a cell cycle involving mitosis or a cell cycle involving binary fission.

[2 marks]

Table 2

Feature	**Cell cycle involving:**	
	mitosis	**binary fission**
Replication of linear DNA		
Replication of circular DNA		
Produces 2 daughter cells		
Produces 4 daughter cells		
Happens in prokaryotic cells		
Happens in eukaryotic cells		

Question 4 continues on the next page

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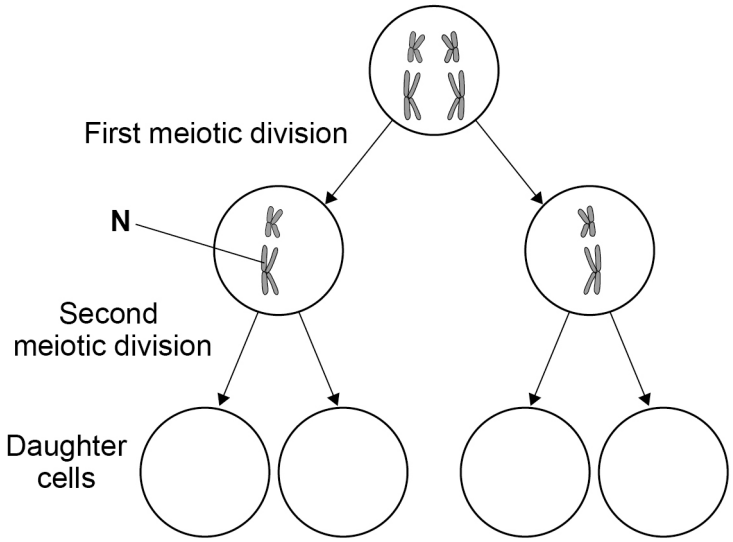
Figure 6 represents a cell undergoing meiosis. It shows the chromosomes in the parent cell and in the two cells formed after the first meiotic division.

The second division of meiosis proceeds normally except that non-disjunction occurs in the chromosome labelled **N**.

Figure 6



0 4 . 3 Complete **Figure 6** to show the chromosomes inside the daughter cells formed after the second meiotic division.

[2 marks]

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Doctors studied babies born with a mutation caused by chromosome non-disjunction during gamete formation in their mother.

They determined each mother's age at the time of childbirth and whether the non-disjunction happened in the first meiotic division (MM1 error) or in the second meiotic division (MM2 error).

Figure 7 shows the doctors' results.

Figure 7

Figure 7 not reproduced here due to third-party copyright restrictions

0 4 . 4 A student concluded that there were more mothers of age >37 with MM2 errors than with MM1 errors.

Using **Figure 7** and suitable calculations show why this conclusion is **not** valid.

[2 marks]

9

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0 5 Two enzymes, **P** and **Q**, are proteins with quaternary structure which catalyse the same reaction, but they have different amino acid sequences.

0 5 . 1 Define the **quaternary structure** of a protein.

[1 mark]

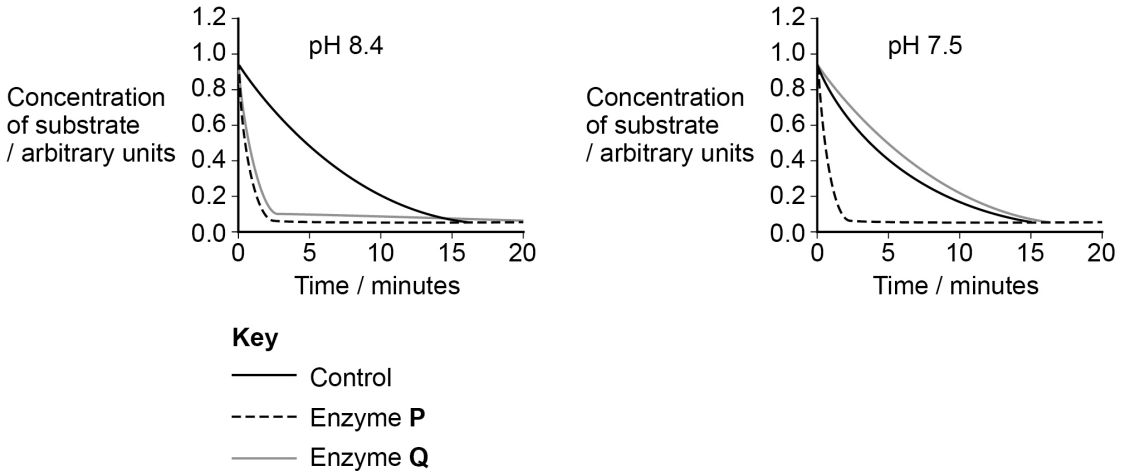
0 5 . 2 Explain how two enzymes with different amino acid sequences can catalyse the same reaction.

[2 marks]

Scientists investigated the effect of pH 8.4 and pH 7.5 on the activity of enzymes **P** and **Q**.

Figure 8 shows their results.

Figure 8



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0 5 . 3 Describe what the scientists should place in the control tubes in this investigation.

[3 marks]

0 5 . 4 Give **three** conclusions you can make from **Figure 8**.

[3 marks]

1

2

3

9

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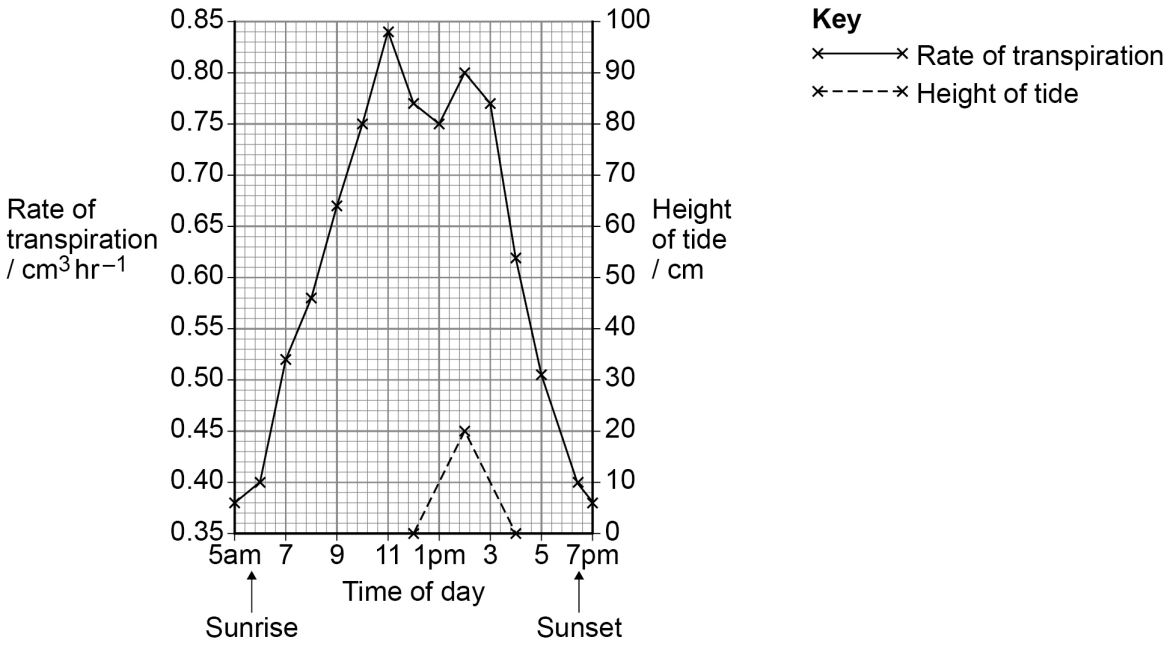
0 6 Mangrove trees grow near the sea. Sea water surrounds the lower parts of the trees at high tide.

Scientists investigated the rate of transpiration in a mangrove tree.
Figure 9 shows the scientists' results.

Figure 9



0 6 . 1 Explain the rate of transpiration between 5 am and midday shown in **Figure 9**.

[4 marks]

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0 6 . 2 Use **Figure 9** to calculate the percentage increase in the rate of transpiration from 1 pm to 2 pm.

[2 marks]

Percentage increase in rate of transpiration _____ %

0 6 . 3 The higher rate of transpiration at high tide shows that the mangrove tree is absorbing water from the sea water surrounding its roots.

Describe an experiment that you could do to investigate whether the mangrove root cells have a lower water potential than sea water.

You are given:
- a piece of fresh mangrove root
- sea water
- access to laboratory equipment.

[4 marks]

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10

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0 7 . 1 Complete **Table 3** to give **three** differences between DNA molecules and tRNA molecules.

[3 marks]

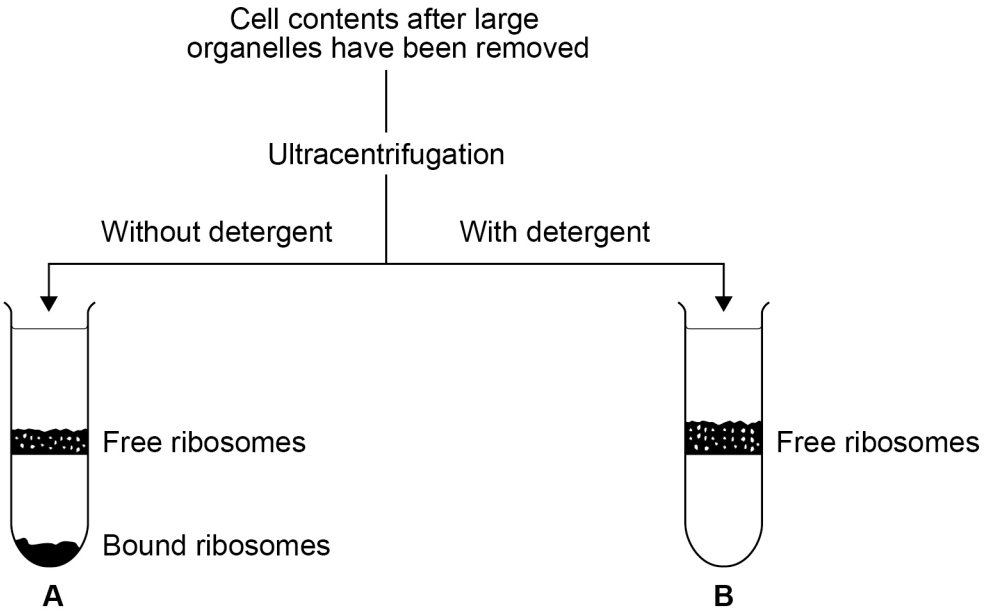
Table 3

DNA molecules	tRNA molecules

Scientists investigated ribosomal RNA in liver cells.

Figure 10 shows the method they used to isolate the ribosomes from the liver cells. The detergent dissolves lipids.

Figure 10



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0 7 . 2 The scientists broke open the cells to produce a suspension of cell contents.

Describe how the scientists would remove large organelles from this suspension of cell contents.

[2 marks]

0 7 . 3 Explain the position of the bands of ribosomes in tubes **A** and **B** in **Figure 10**.

[3 marks]

A

B

8

Turn over for the next question

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0 8 **Figure 11** shows images of gills from two fish as seen through an optical microscope.

Image **C** shows gills from a fish with healthy gills.

Image **D** shows gills from a fish with damaged gills.

Figure 11

Figure 11 not reproduced here due to third-party copyright restrictions

0 8 . 1 To observe the fish gills with the optical microscope, the scientists used **two** different stains. The first stain binds to DNA; the second stain binds to the red blood cells.

Explain why a second stain would be needed to stain the red blood cells.
Suggest which molecule the stain could bind to in the red blood cells.

[2 marks]

Explanation _____

_____

_____

Molecule _____

Do not write outside the box

0 8 . 2 Using **Figure 11**, the scientists calculated the surface area to volume ratios for each gill filament in these two fish. Some of their results are shown in **Table 4**.

Complete **Table 4**. State your calculated volume and surface area:volume ratio to 2 significant figures.

[2 marks]

Table 4

Fish gill	**Surface area / μm^2**	**Volume / μm^3**	**Surface area:volume ratio**
Healthy	7.4×10^3	2.3×10^4	_____
Damaged	1.1×10^4	_____	0.13:1

0 8 . 3 The damage to the gills causes uncontrolled cell division in the cells around the capillaries in the gill filaments.

Other than surface area:volume ratio, describe **one** way this uncontrolled cell division changes the gills, as shown in **Figure 11**.

Explain how this difference would affect gas exchange.

[3 marks]

Difference _____

_____

_____

Explanation _____

_____

_____

_____

_____

_____

Question 8 continues on the next page

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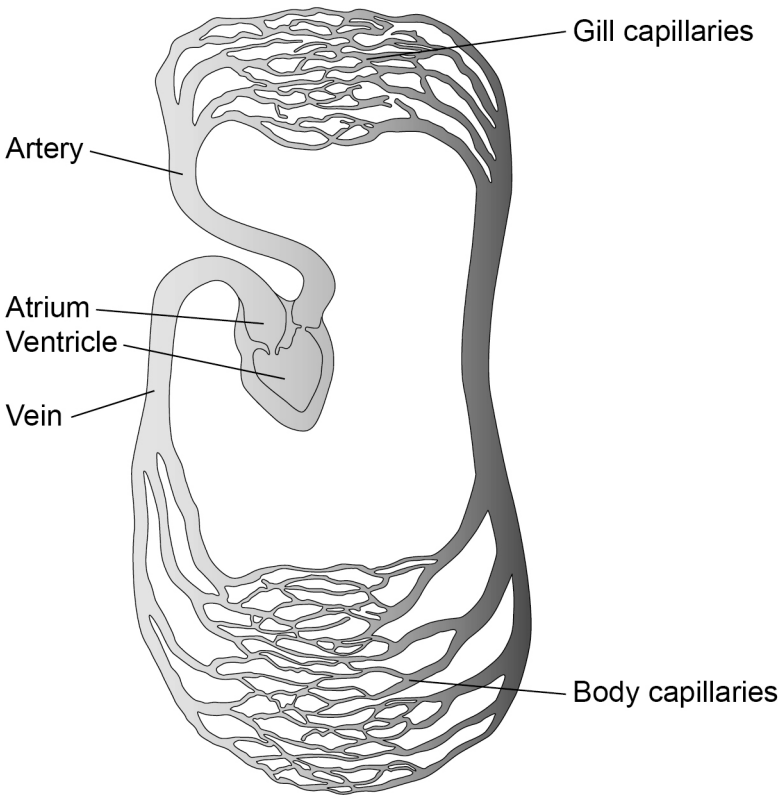
Figure 12 shows the general pattern of blood circulation in fish.

Figure 12



0 8 . 4 Use **Figure 12** to complete **Table 5** to show **two** differences between the circulation of blood in fish and the circulation of blood in a mammal.

[2 marks]

Table 5

Difference	Circulation of blood in fish	Circulation of blood in mammal
1		
2		

9

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0 9 . 1 Describe the transport of carbohydrate in plants.

[5 marks]

Question 9 continues on the next page

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0 9 . 2 Compare and contrast the structure of starch and the structure of cellulose.

[6 marks]

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0 9 . 3 Describe the complete digestion of starch by a mammal.

[4 marks]

15

END OF QUESTIONS

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