A

AQA

Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

A-level

BIOLOGY

Paper 1

7402/1

Time allowed: 2 hours

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

J U N 2 2 7 4 0 2 1 0 1

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

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the spaces provided. Do not write 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.**

DO NOT TURN OVER UNTIL TOLD TO DO SO

Answer ALL questions in the spaces provided.

0 1 . 1

Describe the structure and function of the nucleus.
[4 marks]

[Turn over]

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]

_____

_____

_____

_____

_____

_____

[Turn over]

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 _____

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[Turn over]

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 is 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

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]

[Turn over]

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]

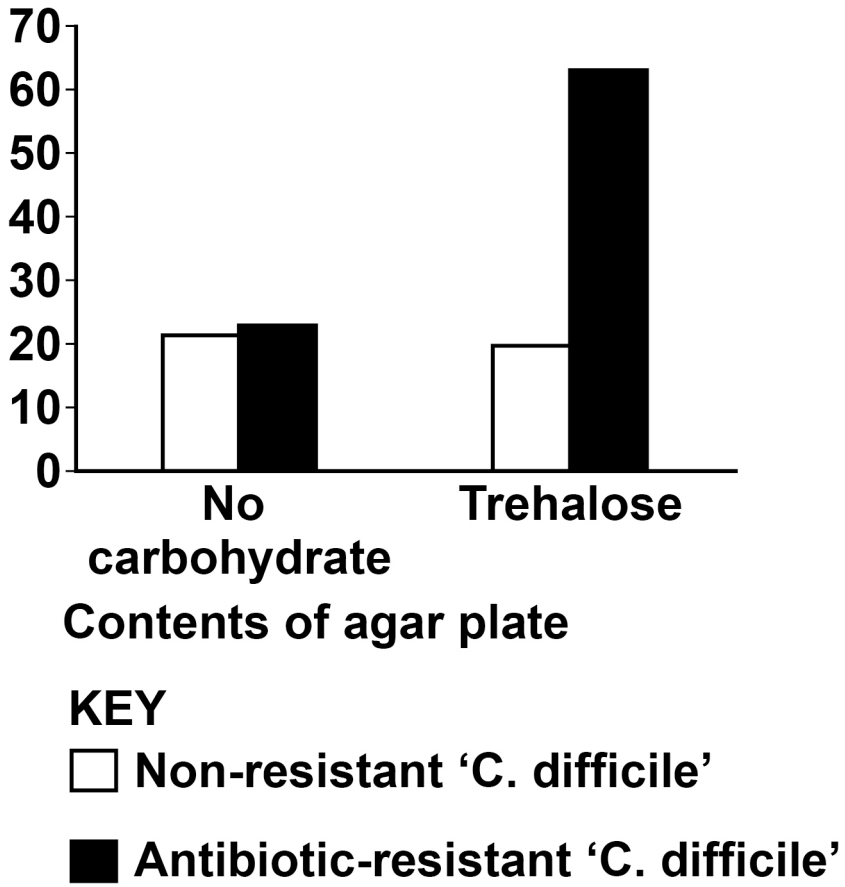
Scientists investigated the effect of trehalose on the growth rate of 'C. difficile'. They grew populations of non-resistant and antibiotic-resistant 'C. difficile' on separate agar plates with:

- **no carbohydrate added**
- **trehalose added.**

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

FIGURE 2, on the opposite page, shows the scientists' results.

FIGURE 2



[Turn over]

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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]

0 2 . 4

Use FIGURE 2, on page 15, to evaluate whether more trehalose in the diet could be a factor in the increased number of antibiotic-resistant 'C. difficile' infections. [3 marks]

[Turn over]

10

0 3 . 1

Give TWO features of ALL prokaryotic cells that are NOT features of eukaryotic cells. [1 mark]

1 _____

_____

2 _____

_____

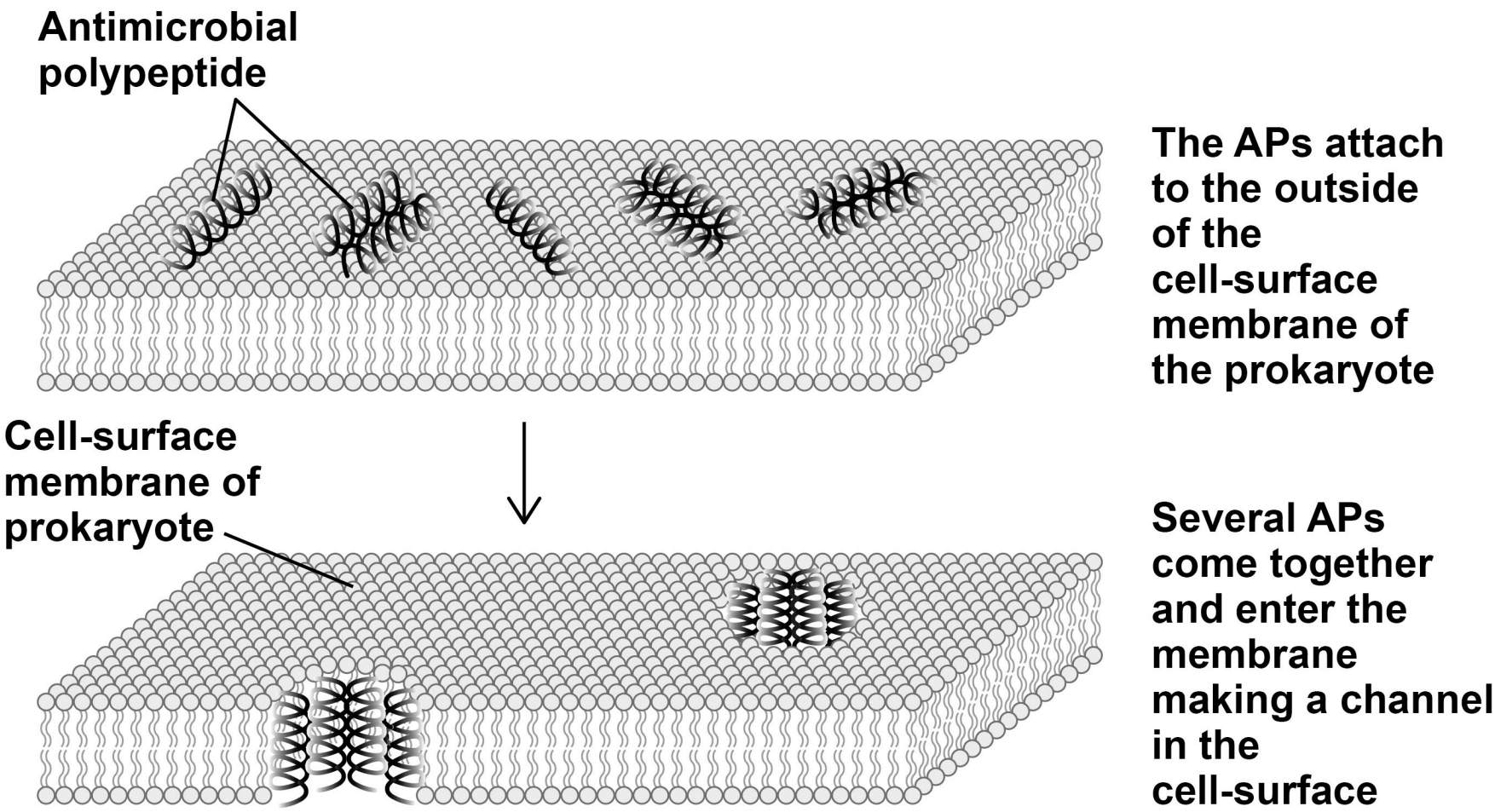
BLANK PAGE

[Turn over]

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

FIGURE 3, on the opposite page, shows how one type of AP acts on the cell-surface membrane of prokaryotes.

FIGURE 3



[Turn over]

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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]

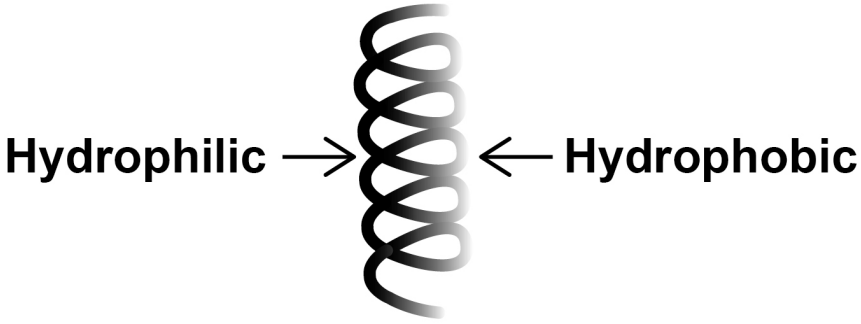
- ☐ **Disulfide**
- ☐ **Hydrogen**
- ☐ **Ionic**
- ☐ **Peptide**

[Turn over]

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

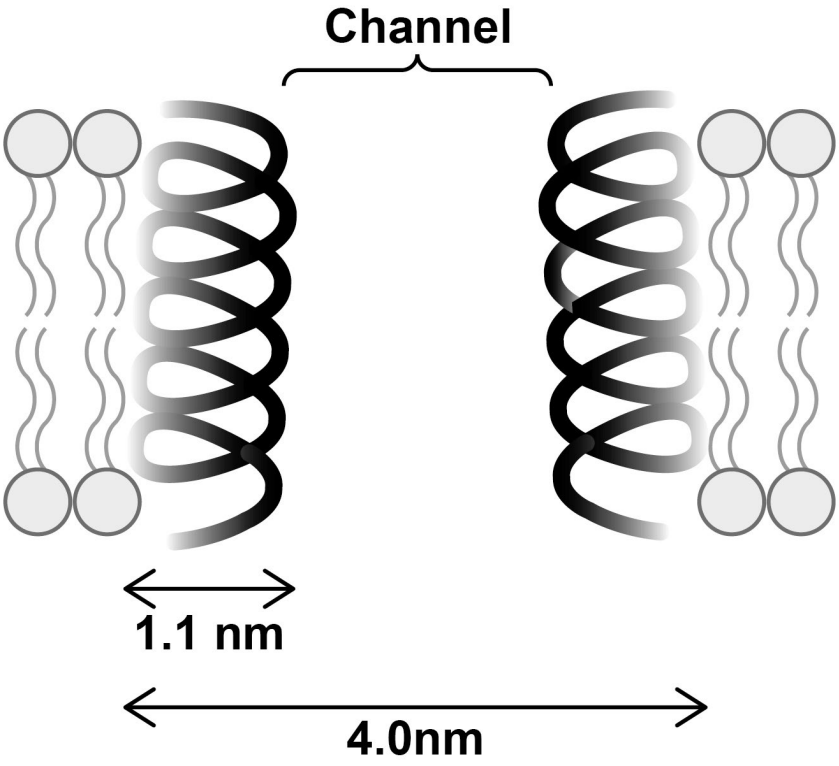


Suggest how these properties of the APs allow them to become positioned across the membrane (as shown in FIGURE 3, on page 23) and make a channel through which ions can pass. [2 marks]

[Turn over]

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 $\pi = 3.14$ in your calculation. Give your answer in nm^2 AND to 1 decimal place. [2 marks]

Answer _____ **nm^2**

[Turn over]

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]

BLANK PAGE

[Turn over]

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]

[Turn over]

11

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

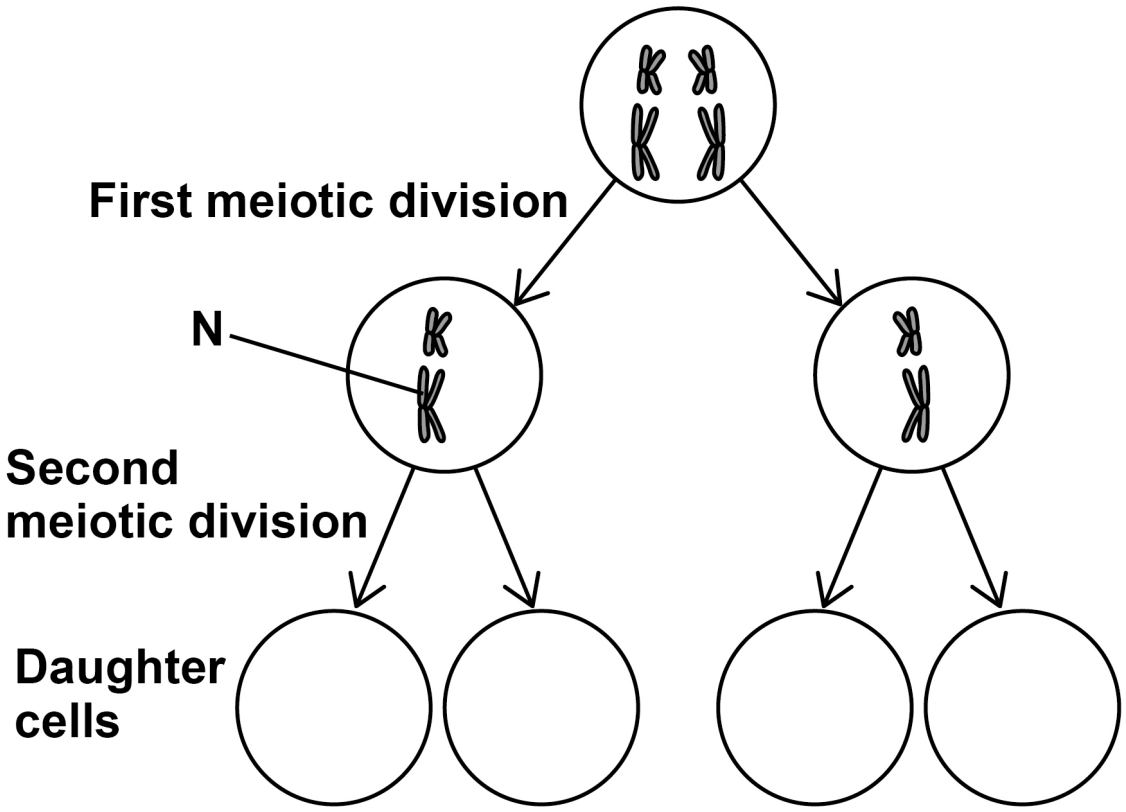
Feature	Cell cycle involving:	
	mitosis	binary fission
Replication of linear DNA		
Replication of circular DNA		
Produces 2 daughter cells		
Produces 4 daughter cells		
Happens in prokaryotic cells		
Happens in eukaryotic cells		

[Turn over]

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, on the opposite page, to show the chromosomes inside the daughter cells formed after the second meiotic division. [2 marks]

[Turn over]

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, on the opposite page, shows the doctors' results.

FIGURE 7

FIGURE 7 is not reproduced here due to third-party copyright restrictions

[Turn over]

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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

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

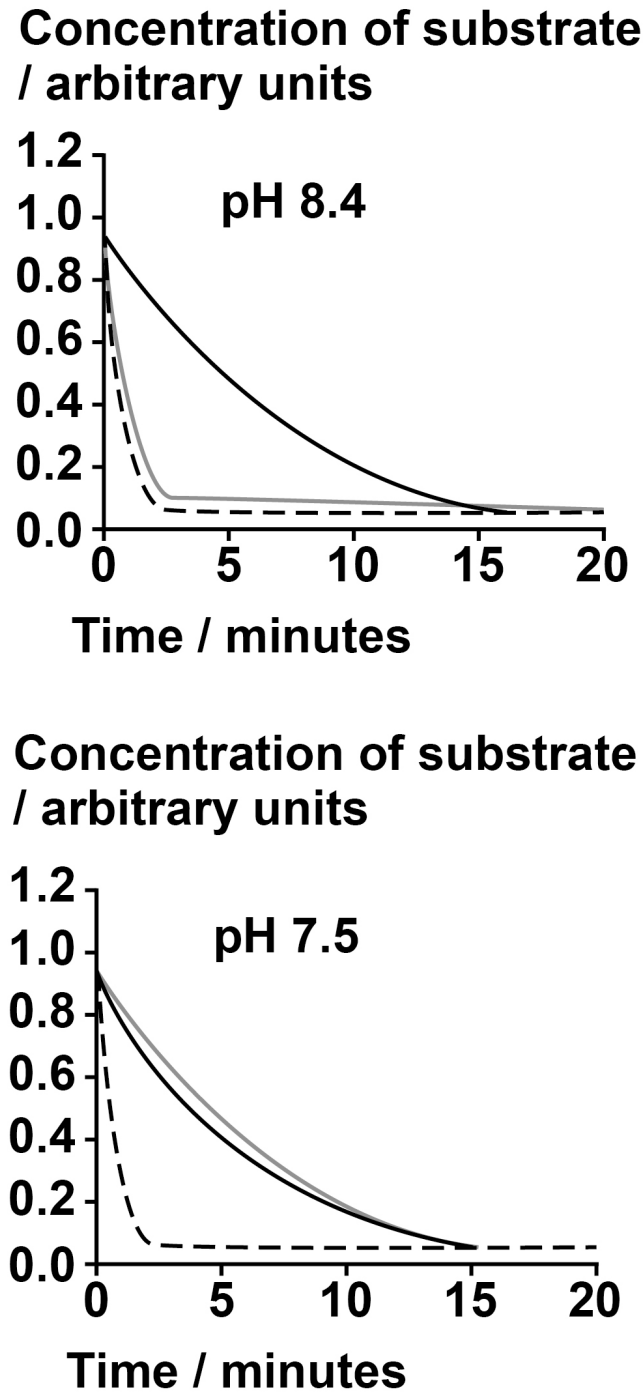
Explain how two enzymes with different amino acid sequences can catalyse the same reaction. [2 marks]

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

FIGURE 8, on page 44, shows their results.

[Turn over]

FIGURE 8


Concentration of substrate / arbitrary units
1.2
1.0
0.8
0.6
0.4
0.2
0.0
pH 8.4
0
5
10
15
20
Time / minutes
Concentration of substrate / arbitrary units
1.2
1.0
0.8
0.6
0.4
0.2
0.0
pH 7.5
0
5
10
15
20
Time / minutes
Key
Control
Enzyme P
Enzyme Q

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, on page 44. [3 marks]

1

2

3 _____

_____

_____

_____

[Turn over]

9

0 6

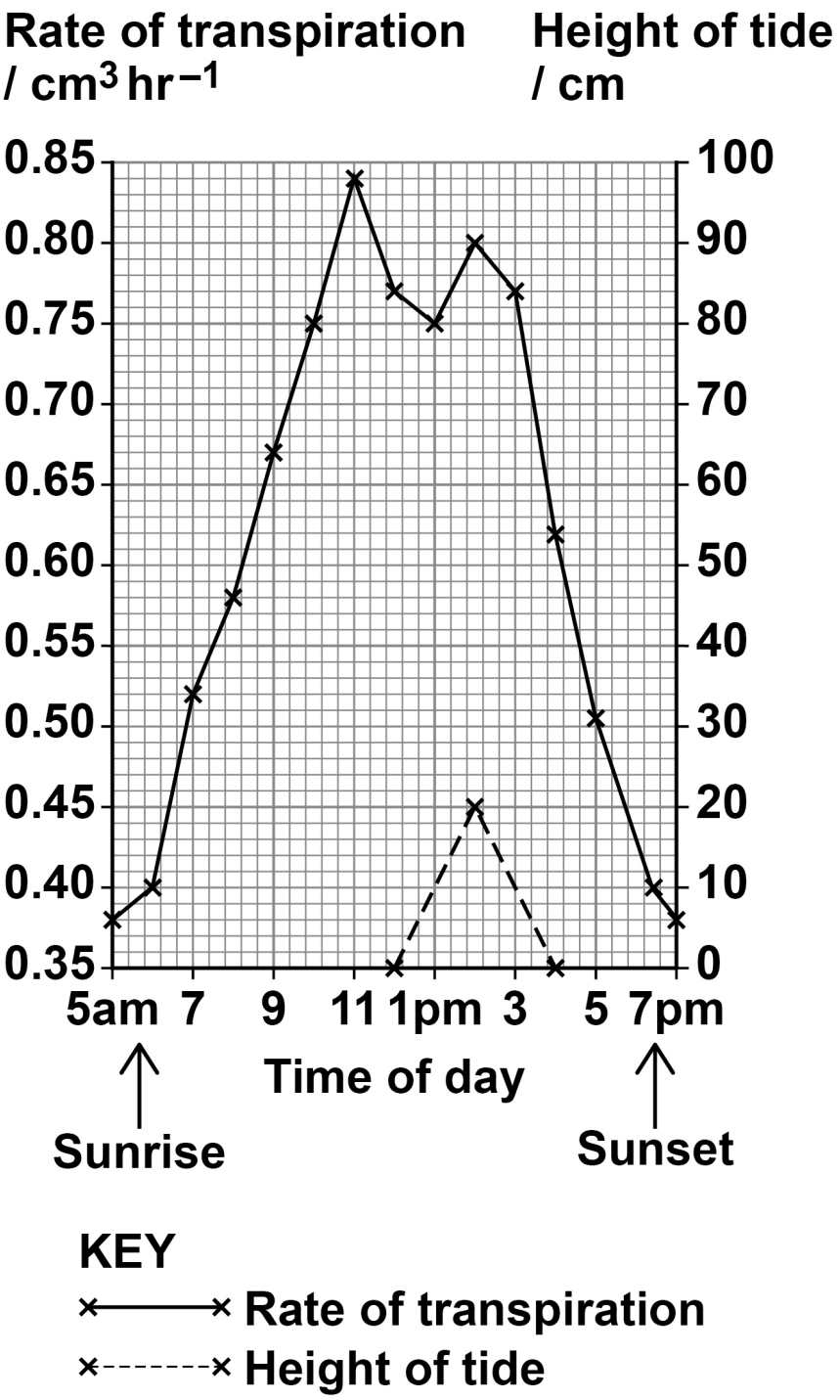
Mangrove trees grow near the sea. Sea water surrounds the lower parts of the trees at high tide.

Scientists investigated the rate of transpiration in a mangrove tree. FIGURE 9, on page 50, shows the scientists' results.

BLANK PAGE

[Turn over]

FIGURE 9


Rate of transpiration / cm3 hr−1
Height of tide / cm
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
100
90
80
70
60
50
40
30
20
10
0
5am 7 9 11 1pm 3 5 7pm
Time of day
Sunrise
Sunset
KEY
Rate of transpiration
Height of tide

0 6 . 1

Explain the rate of transpiration between 5 am and midday shown in FIGURE 9. [4 marks]

0 6 . 2

Use FIGURE 9, on page 50, 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]

10

0 7 . 1

Complete TABLE 3 to give THREE differences between DNA molecules and tRNA molecules. [3 marks]

TABLE 3

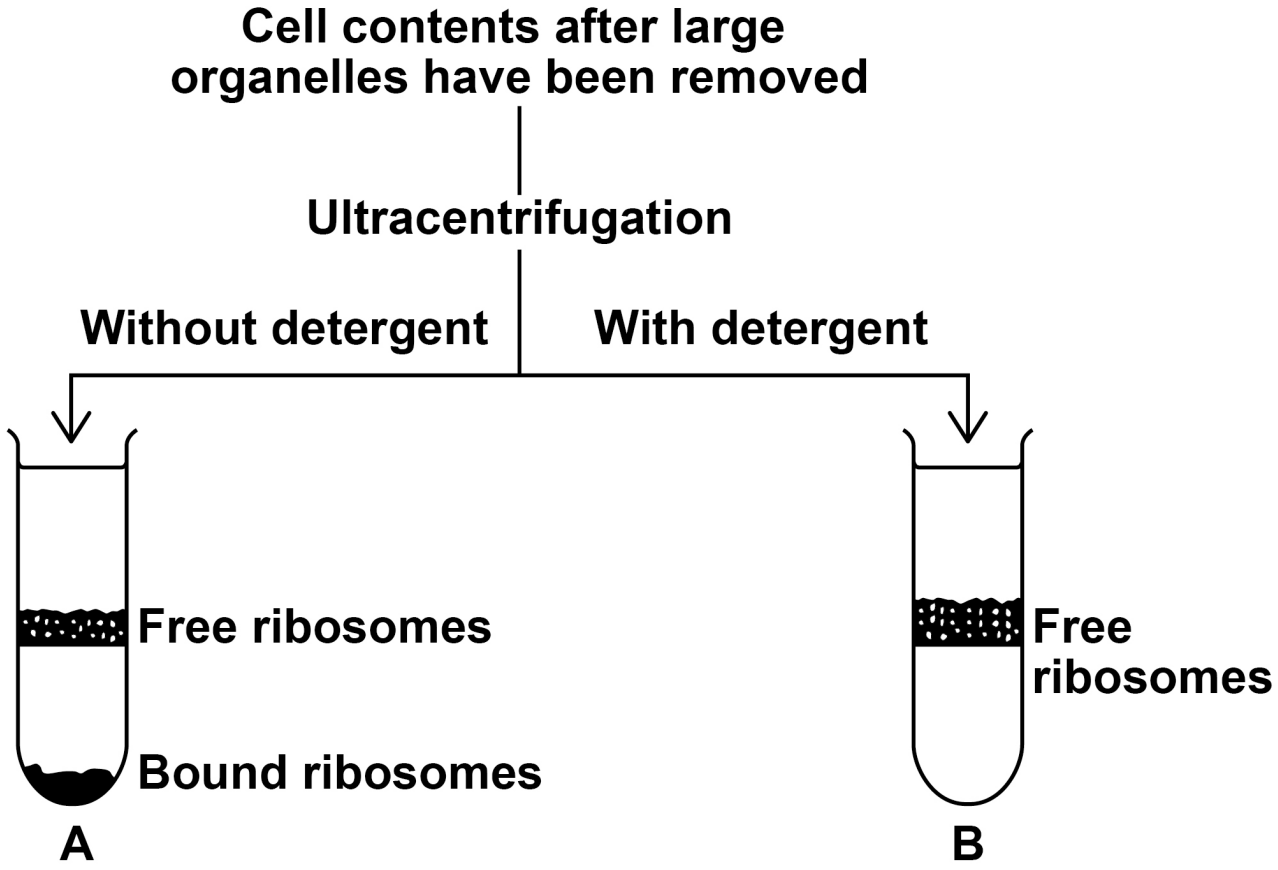
DNA molecules	tRNA molecules

[Turn over]

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



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, on page 56. [3 marks]

A _____

B _____

8

BLANK PAGE

[Turn over]

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 is 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 _____

_____

[Turn over]

REPEAT OF FIGURE 11

FIGURE 11 is not reproduced here due to third-party copyright restrictions

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

[Turn over]

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, on page 62.

Explain how this difference would affect gas exchange. [3 marks]

Difference _____

_____

_____

_____

Explanation _____

_____

_____

_____

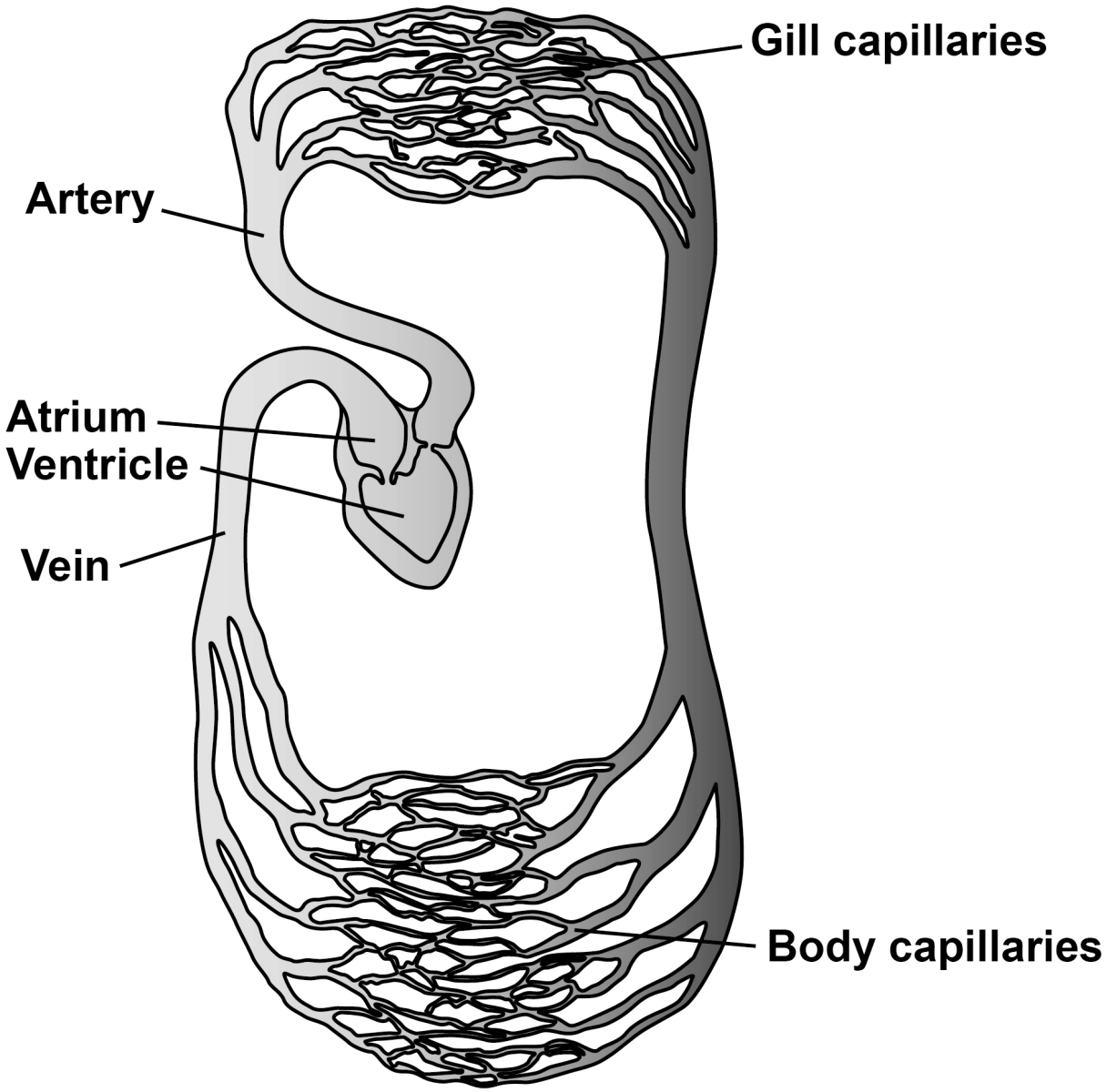
_____

_____

[Turn over]

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

0 9 . 1

Describe the transport of carbohydrate in plants.
[5 marks]

[Turn over]

0 9 . 2

Compare and contrast the structure of starch and the structure of cellulose. [6 marks]

[Turn over]

0 9 . 3

Describe the complete digestion of starch by a mammal. [4 marks]

END OF QUESTIONS

15

Additional page, if required.
Write the question numbers in the left-hand margin.

Additional page, if required.
Write the question numbers in the left-hand margin.

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For Examiner's Use	
Question	Mark
1	
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9	
TOTAL	