Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

AS BIOLOGY

Paper 1

Monday 15 May 2023 Morning Time allowed: 1 hour 30 minutes

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.

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

Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 75.

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

Do not write outside the box

0 1 . 1 Describe the primary structure of all proteins.

[2 marks]

0 1 . 2 This question is about the genetic code.

Define **universal**, **non-overlapping** and **degenerate**.

[3 marks]

Universal

Non-overlapping

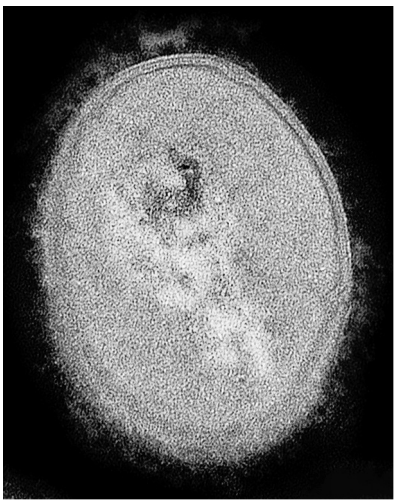
Degenerate

5

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0 2 **Figure 1** shows a transmission electron microscope (TEM) image of a *Streptococcus* bacterium.

Figure 1



0 2 . 1 Describe how the appearance of the area containing DNA in a TEM image of a eukaryotic cell would differ from that shown in **Figure 1**.

[2 marks]

0 2 . 2 Describe **one** difference between the structure of DNA in a prokaryotic cell and in a eukaryotic cell.

[1 mark]

Question 2 continues on the next page

Do not write outside the box

0 2 . 3 *Streptococcus* bacteria can infect the lungs when air is breathed in and cause lung disease.

Describe the mechanism of breathing that causes air to enter the lungs.

[3 marks]

0 2 . 4 Some strains of *Streptococcus* bacteria are more likely to cause lung disease than other strains.

Strains that do not cause lung disease are quickly destroyed by phagocytes. Phagocytes are stimulated when they bind to murein on *Streptococcus* bacteria.

Each strain of *Streptococcus* bacteria has a capsule of different thickness from the others.

Suggest how *Streptococcus* bacteria with a thicker capsule are more likely to survive **and** so cause lung disease.

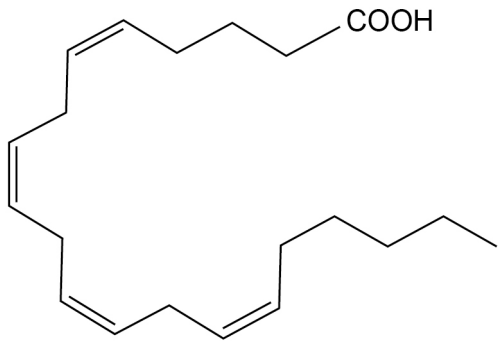
[2 marks]

8

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0 3 . 1 **Figure 2** shows a fatty acid that contains 20 carbon atoms and four double bonds.

Figure 2

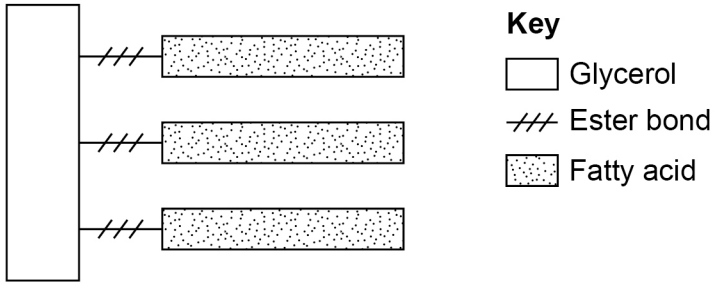


On **Figure 2**, draw a box around the R group of the fatty acid.

[1 mark]

0 3 . 2 **Figure 3** shows a triglyceride.

Figure 3



Describe **two** differences between the structure of the triglyceride shown in **Figure 3** and a phospholipid.

[2 marks]

1 _____

_____

2 _____

_____

Question 3 continues on the next page

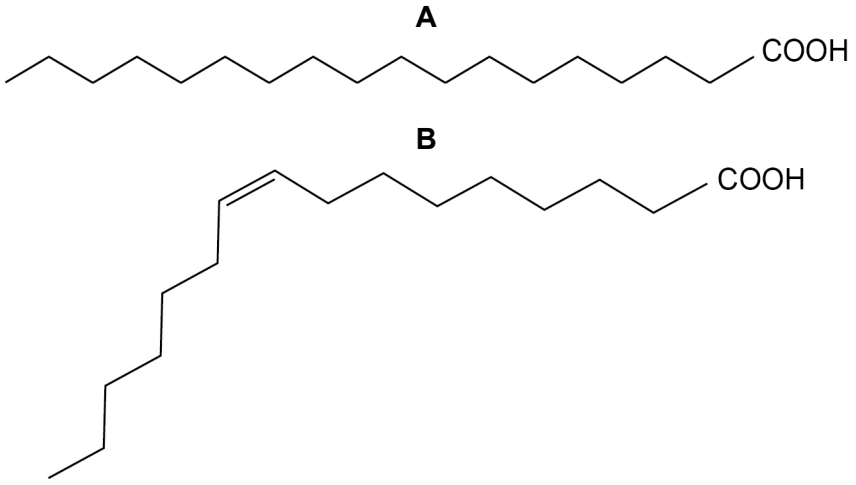
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0 3 . 3 Explain why phospholipids can form a bilayer but triglycerides cannot.

[3 marks]

0 3 . 4 **Figure 4** shows two fatty acids, **A** and **B**.

Figure 4



Scientists fed rats a diet with added fish oil for 4 months.

They obtained samples of red blood cells from the rats before starting this diet (0 months) and after 4 months on this diet.

For each red blood cell sample, they separated the cell-surface membranes and measured:

- the percentage of phospholipids containing each of the fatty acids **A** and **B**
- the fluidity of the membrane.

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Table 1 shows the scientists' results.

Table 1

Time sample of red blood cells obtained / months	Mean percentage of phospholipids containing fatty acid A	Mean percentage of phospholipids containing fatty acid B	Mean fluidity of the membrane / arbitrary units
0	19.8	1.7	31
4	11.7	9.0	97

Suggest why the fluidity of the membrane was higher after 4 months.

Use all the information provided in the question.

[3 marks]

9

Turn over for the next question

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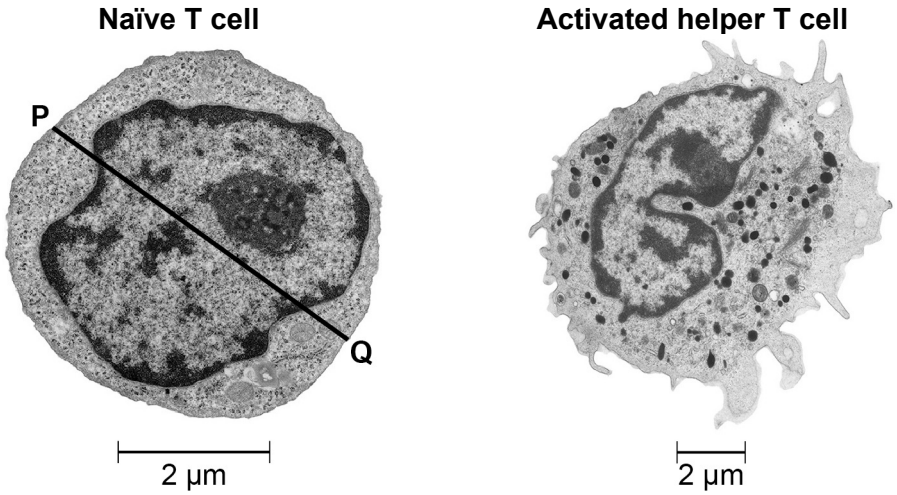
0 4 Scientists investigated the activation of T lymphocytes.

The scientists studied two types of cell:

- naïve T cells, which are T cells that have not yet been in contact with a foreign antigen
- activated helper T cells, which are T cells that have been activated by a foreign antigen.

Figure 5 shows electron microscope images of the two types of cell.

Figure 5



The activated helper T cell has a volume of 463 µm^3

0 4 . 1 Calculate the volume of the naïve T cell shown in **Figure 5**.
Then calculate how many times larger the activated helper T cell volume is compared with the naïve T cell volume.
Assume the cell is spherical.
Use line **PQ** to measure the diameter of the naïve T cell.

Volume of a sphere = $\frac{4}{3}\pi r^3$ where π is 3.14

Show your working.

[3 marks]

Volume of naïve T cell _____ µm^3

Number of times larger the activated helper T cell volume is compared with the naïve T cell volume _____

Do not write outside the box

0 4 . 2 State **one** feature that shows the images in **Figure 5** were taken with an electron microscope and **not** an optical microscope.

Explain your answer.

[2 marks]

0 4 . 3 State **one** role of a helper T cell.

[1 mark]

0 4 . 4 The rate of translation is increased in T cells activated by antigens.

Describe the role of tRNA in translation.

[2 marks]

8

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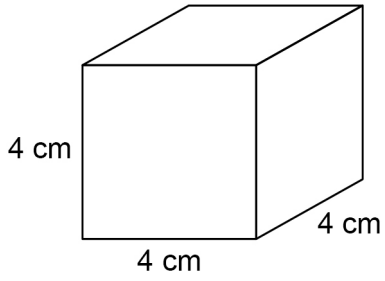
0 5 A student investigated the effect of changing surface area on the rate of diffusion of a solution into the centre of agar blocks.

She used agar coloured by an indicator. The indicator is pink at pH > 8 and colourless at pH 8 and pH < 8

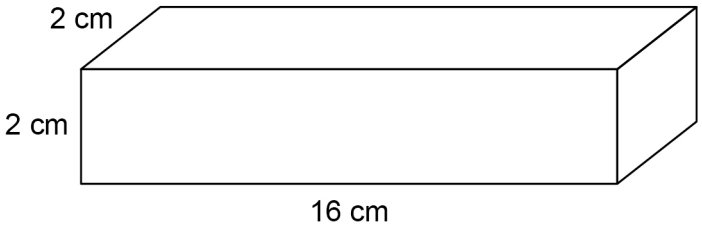
She cut blocks in different shapes as shown in **Figure 6**.

Figure 6

C



D



0 5 . 1 Complete **Table 2** to show the surface area and the surface area to volume ratio for the two shapes.

Table 2

Shape	Surface area / cm^2	Volume / cm^3	Surface area to volume ratio
C	_____	64	_____ : 1
D	_____	64	_____ : 1

[2 marks]

Do not write outside the box

0 5 . 2 The student put the blocks into an acidic solution.

The acidic solution caused the blocks to gradually turn from pink to colourless.

She recorded the time taken for the blocks to turn completely colourless.
She repeated this three times.

Table 3 shows the student's results.

Table 3

Shape	**Time for block to turn colourless / s**				**Mean time for block to turn colourless / s**
	Block 1	Block 2	Block 3	Block 4	
C	3490	1200	3540	3530	_____
D	1680	1500	1590	1610	1595

After collecting the data, the student noticed that shape **C**, block 2 was damaged.

Calculate the mean for shape **C**.

[1 mark]

0 5 . 3 Suggest what the student should have done when she saw that shape **C**, block 2 was damaged.

[1 mark]

_____

_____

_____

0 5 . 4 State **three** variables the student controlled in order to obtain valid results.

[2 marks]

1 _____

2 _____

3 _____

Question 5 continues on the next page

Do not write outside the box

0 5 . 5 Describe how gas exchange occurs in single-celled organisms **and** explain why this method cannot be used by large, multicellular organisms.

[3 marks]

9

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0 6 The human papilloma virus contains a double-stranded DNA genome.

0 6 . 1 Which components are found in a human papilloma virus?

Tick (✓) **one** box.

[1 mark]

Capsid and attachment protein ☐

Capsid, attachment protein and reverse transcriptase ☐

Capsule and attachment protein ☐

Cell-surface membrane and attachment protein ☐

0 6 . 2 The DNA-replication enzymes of a human cell make copies of the human papilloma virus genome.

Name **two** enzymes that are involved in replicating the DNA of the human papilloma virus and describe their roles in the replication process.

[3 marks]

Name of enzyme 1 _____

Role of enzyme 1 _____

_____

_____

Name of enzyme 2 _____

Role of enzyme 2 _____

_____

_____

Question 6 continues on the next page

Do not write outside the box

0 6 . 3 Human papilloma virus infects cells that are no longer dividing. The human papilloma virus genome contains genes that code for proteins that cause human cells to restart their cell cycles.

Human papilloma virus infection can cause cancer.

Explain why.

[1 mark]

0 6 . 4 Human papilloma virus (HPV) is transmitted through sexual contact.

More than 95% of cervical cancers (which only affect females) are due to HPV infection. HPV infection of other tissues increases the risk of cancer but this is rare compared with cervical infection.

A vaccine is available that is over 80% effective at preventing HPV infection, if given before the person has been exposed to HPV. There is evidence of herd immunity when more than 50% of the population have been vaccinated.

Evaluate whether 10- to 12-year-old boys should be given the HPV vaccine.

[4 marks]

9

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Turn over for the next question

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0 7 Scientists investigated biodiversity in prokaryote communities found in soil.

The scientists:

- took soil samples from fields that had been managed for 20 years with two different farming methods
- sequenced all the DNA that coded for prokaryotic ribosomal RNA in the soil samples
- compared these base sequences to give a measure of species richness and an index of diversity for the prokaryote community
- recorded the total prokaryotic biomass and the mass of stored carbon for each soil sample
- obtained the mean wheat yield from the fields.

Table 4 shows the scientists' results.

Table 4

Data collected	**Farming method 1**	**Farming method 2**
Mean species richness (± 2 × standard deviation)	517 (± 17)	560 (± 24)
Mean index of diversity (± 2 × standard deviation)	0.251 (± 0.011)	0.230 (± 0.014)
Mean total prokaryotic biomass / kg m^{-3}	0.24	0.40
Mean carbon stored in soil organisms / μg g^{-1}	203	342
Mean wheat yield / g m^{-2}	451	377

The mean ± 2 × standard deviation includes 95% of the data.

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0 7 . 1 Using the standard deviation data from **Table 4**, describe the differences in prokaryotic biodiversity found in the soil with these two farming methods.

In your answer, give the definitions of **species richness** and **index of diversity**.

[4 marks]

Question 7 continues on the next page

Do not write outside the box

0 7 . 2 Genetic diversity in soil species was traditionally inferred by making observations after growing prokaryotes on agar plates.

However, it is estimated that less than 10% of prokaryotes found in soil will grow if spread on an agar plate in a laboratory.

In recent years, our knowledge of prokaryotic biodiversity in the soil has increased.

Suggest why.

[2 marks]

0 7 . 3 Evaluate the balance between conservation and farming for these two farming methods.

Use the information provided in **Table 4** (on page 16).

[2 marks]

8

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0 8 . 1 A student prepared a plant root to observe cells undergoing mitosis.

He put the root in a small bottle of hydrochloric acid in a 40 °C water bath.

Why did he put the plant root in acid?

[1 mark]

0 8 . 2 State **two** precautions required when working with hydrochloric acid.

[2 marks]

1

2

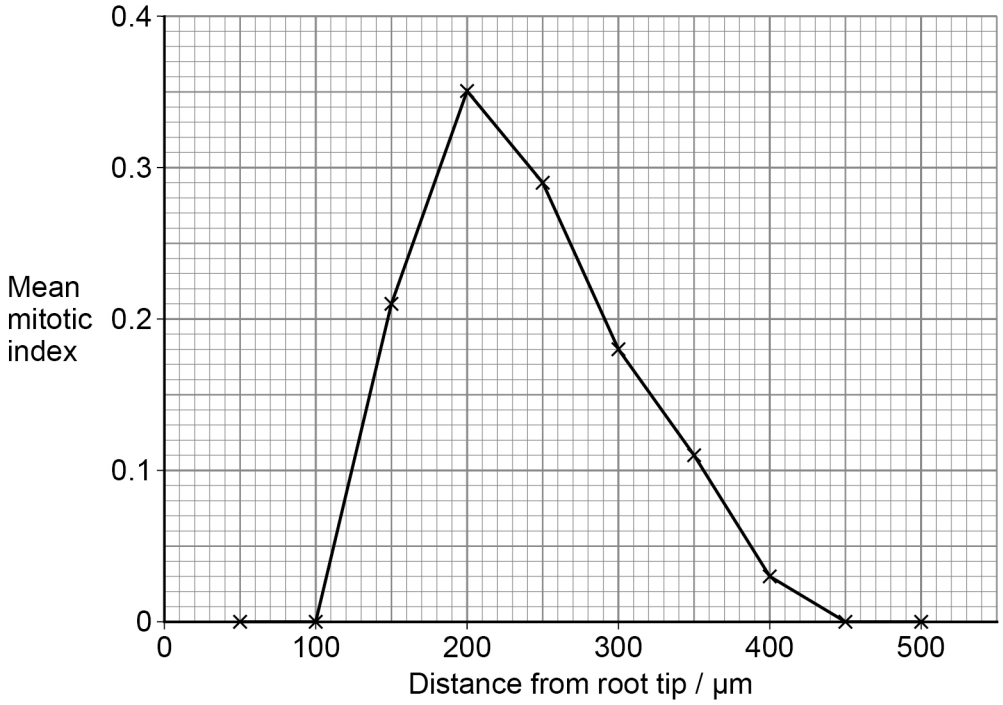
Question 8 continues on the next page

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0 8 . 3 Scientists determined the mean mitotic index at 50 μm intervals away from the root tip in 10 young plant roots.

Figure 7 shows the scientists' results.

Figure 7



State the null hypothesis for this investigation.

Name the statistical test needed to determine whether the difference between the mean mitotic index at 200 μm and at 300 μm is significant.

[2 marks]

Null hypothesis _____

_____

_____

Statistical test _____

Do not write outside the box

0 8 . 4 The scientists recorded these measurements from the tissue located at 200 μm from the root tip.

Area of field of view = 0.2 mm^2
Mean area of one cell = 3495 μm^2

Use this information and **Figure 7** to calculate the number of cells undergoing mitosis in this location.

Assume there are no spaces between the cells.

Show your working.

[2 marks]

_____ cells

0 8 . 5 Another student compares the mitotic index in the roots of two different species.

Give **two** considerations within her method to ensure this comparison is valid.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

9

Turn over for the next question

Do not write outside the box

0 9 Read the following passage.

Carbohydrates are moved by mass transport in plants and in mammals. This movement is caused by a pressure gradient inside the transport vessels.

Plants transport most of their carbohydrate as sucrose. The phloem has sucrose-transport proteins in the cell-surface membrane. Potato plants with fewer sucrose-transport proteins produce fewer potatoes and accumulate sugars in their leaves.

Mammals do not have sucrose-transport proteins in their cell-surface membranes. They do have many monosaccharide-transport proteins in cell-surface membranes. These transport proteins allow monosaccharides through by facilitated diffusion.

Mammalian cells can change the number of glucose-transport proteins in their cell-surface membranes. The glucose-transport proteins are stored in internal membranes, then moved to the cell-surface membrane when they are needed. During exercise, there is a significant increase in glucose uptake by muscle cells.

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

0 9 . 1 Explain how sucrose-transport proteins in leaf cells enable the production of a pressure gradient in the phloem.

[3 marks]

Do not write outside the box

0 9 . 2 Potato plants with fewer sucrose-transport proteins produce fewer potatoes and accumulate sugars in their leaves (lines 4, 5 and 6).

Explain why.

[2 marks]

0 9 . 3 During exercise, there is a significant increase in the glucose uptake by muscle cells (lines 14 and 15).

Give **two** reasons why glucose uptake by muscle cells increases significantly during exercise.

Explain your answers.

[4 marks]

1

2

Question 9 continues on the next page

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0 9 . 4 Which statement correctly describes the structure of both a sucrose-transport protein and a glucose-transport protein?

Tick (✓) **one** box.

[1 mark]

The secondary structure is held by disulfide bridges.
The tertiary structure allows the protein to be positioned on the inner surface of the cell membrane. ☐

The secondary structure is held by disulfide bridges.
The tertiary structure allows the protein to be positioned spanning the whole cell membrane. ☐

The secondary structure is held by hydrogen bonds.
The tertiary structure allows the protein to be positioned on the outer surface of the cell membrane. ☐

The secondary structure is held by hydrogen bonds.
The tertiary structure allows the protein to be positioned spanning the whole cell membrane. ☐

10

END OF QUESTIONS

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