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

Wednesday 5 June 2024 Afternoon 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.

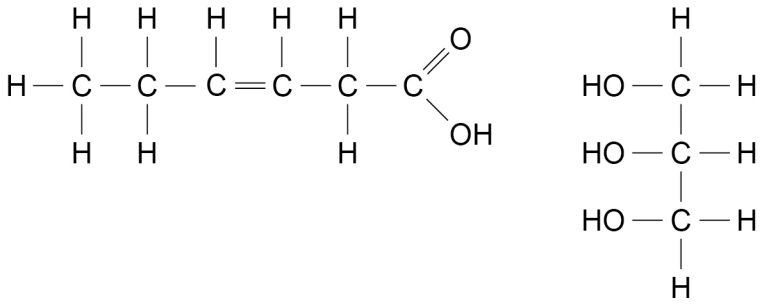
For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Do not write outside the box

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

0 1 . 1 **Figure 1** shows the structure of a fatty acid molecule and the structure of a glycerol molecule.

Figure 1



On **Figure 1**, **draw a circle** around the part of the fatty acid molecule **and** the part of the glycerol molecule that is removed to form a bond in a triglyceride molecule.

Name the bond formed between a fatty acid and glycerol in a triglyceride molecule.

Name the reaction involved in forming a bond between a fatty acid and glycerol in a triglyceride molecule.

[3 marks]

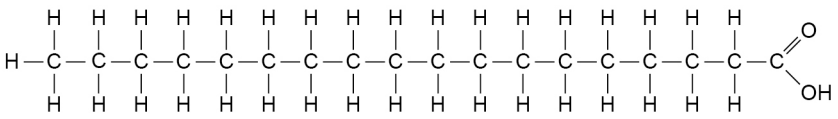
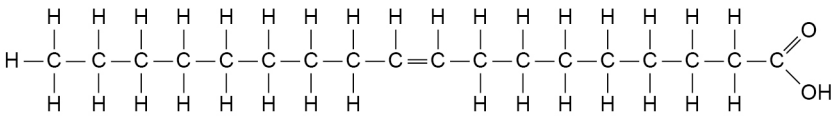
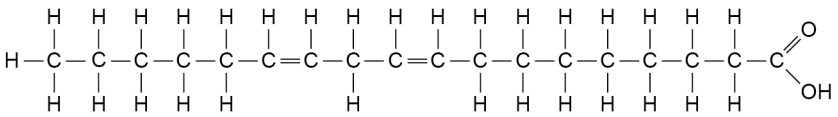
Bond _____

Reaction _____

Do not write outside the box

Table 1 shows information about three fatty acids.

Table 1

Name of fatty acid	Diagram of fatty acid structure	Fatty acid melting point / °C
Stearic acid		70
Oleic acid		14
Linoleic acid		–5

0 1 . 2 Name the fatty acid shown in **Table 1** that is a saturated fatty acid.

[1 mark]

_____

0 1 . 3 The melting point is the temperature at which a solid changes state to be a liquid.

Use **Table 1** to describe the relationship between fatty acid structure and fatty acid melting point.

[1 mark]

_____

_____

_____

Question 1 continues on the next page

Do not write outside the box

0 1 . 4 The ratio of saturated to unsaturated fatty acids in a cell-surface membrane determines the extent of the membrane's fluidity.

Scientists provided a cell culture of mouse phagocytes with liquid broth rich in unsaturated fatty acids.

The scientists observed:

- an increase in the proportion of phospholipids in the phagocytes containing unsaturated fatty acids
- more phagocytosis.

Suggest and explain why there was more phagocytosis.

[3 marks]

8

Do not write outside the box

0 2 . 1 Describe the processes of facilitated diffusion and active transport.

[3 marks]

Facilitated diffusion _____

_____

_____

_____

_____

_____

Active transport _____

_____

_____

_____

_____

_____

0 2 . 2 What are microvilli?

[1 mark]

_____

_____

_____

Question 2 continues on the next page

Do not write outside the box

0 2 . 3 Vitamin A is a fat-soluble substance.

Micelles are involved in the process of vitamin A absorption.

Describe the process of vitamin A absorption into cells lining the ileum.

[3 marks]

7

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 3 . 1 Describe how we breathe in.

[3 marks]

0 3 . 2 A scientist prepared alveolar tissue to view using an optical microscope. The scientist cut very thin slices of the alveolar tissue.

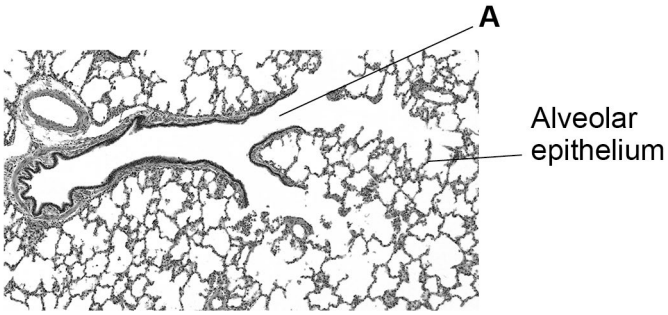
Explain why the scientist used very thin slices of alveolar tissue with the optical microscope.

[2 marks]

Do not write outside the box

0 3 . 3 **Figure 2** is an image of the lung tissue observed using an optical microscope.

Figure 2



Identify the tube labelled **A**.

[1 mark]

A _____

The scientist used a ruler to measure the diameter of some of the alveoli.

Table 2 shows the scientist's results.

Table 2

Alveolus diameter / mm								
Alveolus diameter / mm	4	2	5	1	2	3	5	2

0 3 . 4 The magnification of the image in **Figure 2** is × 40

Use this information and **Table 2** to calculate the mean diameter, in μm, of the alveoli.

Show your working.

[2 marks]

Answer _____ μm

Do not write outside the box

0 3 . 5 Give the uncertainty associated with taking a measurement using a ruler with 1 mm graduations.

Calculate the percentage error for a measurement using the ruler of 4 mm

[2 marks]

Uncertainty ± _____ mm

Percentage error _____

10

Do not write outside the box

0 4 . 1 Molasses is a solution obtained from sugar beet plants. The sugars present in molasses are sucrose, glucose and fructose.

Give the number of different types of monosaccharides present in molasses.

[1 mark]

_____

0 4 . 2 A student used the biochemical test for reducing sugars on a clear sample of molasses.

Describe the biochemical test for a reducing sugar.

Explain the result expected from the test on the sample of molasses.

[3 marks]

Description of biochemical test _____

_____

_____

_____

Explanation of expected result _____

_____

_____

_____

0 4 . 3 'Free sugar' is the sugar in food and drinks released when food is crushed or when sugar is added to food at home or by manufacturers.

Scientists recommend that no more than 5% of the energy consumed per day should come from 'free sugar'.

The mean daily energy requirement for a 10-year-old child is 8100 kJ

The 'free sugar' in one tablespoon of molasses contains 250 kJ of energy.

Calculate the number of tablespoons of molasses required for a 10-year-old child to reach the recommendation for energy consumed in 'free sugar' per day.

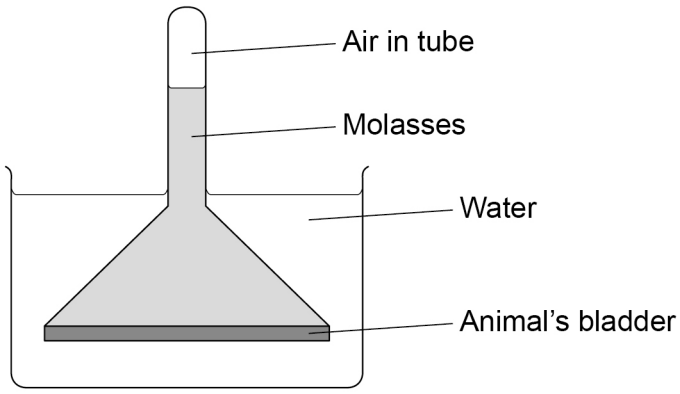
[1 mark]

Number of tablespoons _____ per day

Do not write outside the box

0 4 . 4 A scientist used the apparatus in **Figure 3** to investigate osmosis.

Figure 3



Use your understanding of osmosis to explain why the air pressure in the tube increased.

[3 marks]

Do not write outside the box

0 4 . 5 The scientist repeated the investigation, but made **one** change to the molasses. The scientist did **not** change the volume of molasses at the start of the investigation.

The scientist observed that the air pressure inside the tube increased by 160 kPa compared with 800 kPa in the first investigation.

Suggest the change the scientist made to the molasses to cause this smaller increase in air pressure.

Use the air pressure figures in a calculation to support your answer.

[2 marks]

Suggested change _____

_____

10

Turn over for the next question

Do not write outside the box

0 5 . 1 Describe the appearance **and** behaviour of chromosomes during prophase and during anaphase of mitosis.

[4 marks]

Prophase _____

_____

_____

_____

Anaphase _____

_____

_____

_____

0 5 . 2 A scientist used an optical microscope to determine the mitotic index in cells at different distances from the tip of onion roots.

Figure 4 shows the results.

Figure 4

Figure 4 not reproduced here due to third-party copyright restrictions

The figure is taken from the following website:

https://legacy.nimbios.org//~gross/bioed/webmodules/mitoticindex.htm#:~:text=Interpretation%3A%20In%20general%2C%20the%20mitotic,of%20the%20root's%20dividing%20cells

Complete the word equation used to determine each mitotic index in **Figure 4**.

[1 mark]

Mitotic Index =

Do not write outside the box

0 5 . 3 The scientist used data from **Figure 4** to calculate a correlation coefficient (r). The scientist then used a statistical test to determine the probability (P) associated with the value of r.

$r = -0.98$ ($P < 0.05$)

What can you conclude from this result?

[2 marks]

0 5 . 4 What can you conclude about the effect that distance from the root tip has on the proportion of cells in different stages of the cell cycle?

Use information in **Figure 4**.

[3 marks]

10

Turn over for the next question

Do not write outside the box

0 6 . 1 Give **three** structural differences between an mRNA molecule and a tRNA molecule.

[3 marks]

mRNA	tRNA

0 6 . 2 **Table 3** shows mRNA codons and the amino acid coded by each codon.

Table 3

First base	Second base				Third base
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
					C
	Leu		Stop	Stop	A
				Trp	G
C	Leu	Pro	His	Arg	U
					C
			Gln		A
					G
A	Ile	Thr	Asn	Ser	U
					C
			Lys	Arg	A
	Met				G
G	Val	Ala	Asp	Gly	U
					C
			Glu		A
					G

Figure 5 shows the mRNA base sequence produced when part of a gene coding for an enzyme is transcribed.

Figure 5

UUU	**CGG**	**GCG**

Use **Table 3** to give the amino acids coded by the mRNA base sequence in **Figure 5**.

[1 mark]

Do not write outside the box

0 6 . 3 A mutation occurred in the part of the gene transcribed in Question **06.2**.

Figure 6 shows the mRNA base sequence produced when the identical part in the mutated gene is transcribed.

Figure 6

UUU	**AGG**	**GCG**

The amino acids coded by this mRNA base sequence form part of the enzyme's active site.

Use all the information in this question to:

- name the type of mutation that occurred to produce the mutated gene
- give the change in **DNA** caused by this mutation
- explain the effect this mutation will have on the function of the enzyme.

[4 marks]

Type of mutation _____

Change in DNA _____

Explanation of effect on function of enzyme _____

_____

_____

_____

_____

_____

8

Turn over for the next question

Do not write outside the box

0 7 . 1 A student investigated the activity of the enzyme polyphenol oxidase (PPO) in apple tissue.

When apple tissue is exposed to air, PPO catalyses a reaction between colourless phenol compounds in apple tissue and oxygen.

Figure 7 shows the reaction.

Figure 7

$$\text{phenol compounds + oxygen} \xrightarrow{\text{PPO}} \text{brown pigment}$$

The student measured the time taken for the brown pigment to appear in two apple varieties (**D** and **E**).

Method

1. Cut a 1 cm cube of apple tissue from variety **D**.
2. Put the cube on a plate and leave the plate at 30 °C
3. Measure the time for the brown pigment to appear.
4. Repeat steps 1 to 3 two more times.
5. Repeat steps 1 to 4 with apple tissue from variety **E**.

The student obtained the results shown below, but did not record the data in a results table.

Variety **D** = 15 min 50 s, 18 min, 14 min 30 s

Variety **E** = 6 min 30 s, 8 min, 7 min

In the box labelled **Figure 8**, design a suitable results table.

- Enter the student's results into the table.
- Calculate the mean results and include these in the table.
- Use 1 decimal place for both mean results.

[3 marks]

Do not write outside the box

Figure 8

0 7 . 2 Suggest and explain why the results for variety **D** are different from the results for variety **E**.

[2 marks]

Question 7 continues on the next page

Do not write outside the box

0 7 . 3 The student repeated the investigation but made **one** change to the method used to prepare the apple tissue.

The student then observed shorter times for the brown pigment to appear in both apple varieties.

Suggest the change the student made to the method of preparing the apple tissue.

Explain why the brown pigment appeared in a shorter time.

Do **not** suggest using a different volume or mass of apple.

[3 marks]

Change to method _____

Explanation _____

_____

_____

_____

_____

_____

0 7 . 4 The student wants to change the procedure to obtain a measure of PPO activity either in terms of how much substrate is used or how much product is produced.

Which change in procedure will provide a successful measure of PPO activity for the student?

Tick (✓) **one** box.

[1 mark]

- Measure the increase in oxygen concentration in the air around the cube of apple tissue on a plate. ☐
- Measure the intensity of brown colour by comparing apple tissue with a colour chart showing a range of apple tissues of known pigment concentration. ☐
- Measure the intensity of colour produced from brown apple tissue in a biuret test. ☐
- Measure the percentage of light transmitted through a cube of brown apple tissue using a colorimeter. ☐

9

Do not write outside the box

0 8 . 1 Give **two** structural features of an aorta wall and explain how they are related to the function of an aorta.

[2 marks]

1 _____

_____

_____

_____

_____

2 _____

_____

_____

_____

_____

Question 8 continues on the next page

Do not write outside the box

0 8 . 2 Small tears may occur in the layers of tissue in an aorta wall. These tears weaken the wall without bursting the aorta.

Scientists:

- measured the aorta diameter (d) in a large population of people over 60 years of age
- calculated the risk of an aorta wall developing a tear.

Table 4 shows their results.

Table 4

Aorta diameter *d* / cm	**Number of people in the population**	**Risk of an aorta wall developing a tear**
$d \leq 3.5$	2765	0.06
$3.5 < d \leq 4.0$	630	0.33
$4.0 < d \leq 4.5$	98	4.64
$d > 4.5$	7	380.00

Blood may push through the tears in the aorta wall. This produces a balloon-like swelling called an aneurysm and increases the aorta diameter. Aneurysms can cause the aorta to burst.

Using all the information, what can you conclude about aorta diameter and the risk of developing an aneurysm?

[3 marks]

Do not write outside the box

0 8 . 3 A scientist investigated changes in a diseased heart and changes in a healthy heart during cardiac cycles.

For each heart, the scientist obtained a value for:

- the mean blood volume in a full ventricle just before the ventricle contracts (**BVB**)
- the mean ejection fraction (**EF**).

The **EF** is the proportion of blood pumped out of a full ventricle in one heartbeat.

The **EF** is calculated using this formula:

$$\text{EF} = \frac{\text{Blood volume pumped out of a full ventricle in one heartbeat (stroke volume)}}{\text{BVB}}$$

Table 5 shows the scientist's results.

Table 5

	Diseased heart	**Healthy heart**
Mean **BVB** / cm^3	100	120
Mean **EF**	0.45	0.58

Using **Table 5**, a student calculated that the percentage change in the stroke volume of the diseased heart compared with the stroke volume of a healthy heart is –30%.

The student's answer is wrong because the final step of the calculation was performed incorrectly.

Using the equation and **Table 5**, calculate the correct percentage change in the stroke volume of the diseased heart compared with the stroke volume of the healthy heart.

Identify the mathematical error in the final step of the student's calculation.

[3 marks]

Correct answer _____ %

Mathematical error _____

8

Do not write outside the box

0 9 Courtship behaviour in the frog species, *Xenopus laevis*, involves male frogs calling to:

- attract sexually active females – these are advertisement calls
- start and continue mating – these are mating calls
- signal when a male is not sexually active – these are rasping calls.

Scientists investigated frog courtship behaviour by feeding a population of sexually active male frogs a diet containing the hormone EE2. The scientists also fed a separate control population of sexually active male frogs a diet without EE2.

They determined the percentage of males making advertisement calls or rasping calls in each population.

Table 6 shows their results.

Table 6

Population	**Percentage of males making:**	
	Advertisement calls	**Rasping calls**
Males fed EE2	94.0	4.0
Males not fed EE2 (control)	97.0	0.5

0 9 . 1 There were 800 males in the control population.

Each male made one type of call.

Use this information and **Table 6** to calculate the number of males making mating calls in the control population.

[1 mark]

Answer _____ males

Do not write outside the box

0 9 . 2 Suggest **one** change the scientists could make to both frog populations to increase the number of mating calls.

[1 mark]

_____

_____

_____

0 9 . 3 The scientists also investigated the effect on **female** frog courtship behaviour of feeding EE2 to male frogs.

Table 7 shows their results.

Table 7

Population	**Median time females spent in courtship / s**
Males fed EE2	8
Males not fed EE2 (control)	16

EE2 is contained in human contraceptive pills. Some EE2 is released in human urine and collects in sewage. Untreated sewage pollutes the water in frog habitats.

Suggest and explain the effect EE2 pollution in frog habitats will have on frog breeding.

Use information from **Table 6** and **Table 7** in your answer.

[4 marks]

Effect on frog breeding _____

Explanation _____

_____

_____

_____

_____

_____

_____

_____

6

Do not write outside the box

1 0 . 1 Describe and explain how you would use cell fractionation **and** ultracentrifugation to obtain a sample of nuclei from muscle tissue.

[6 marks]

Do not write outside the box

1 0 . 2 Describe the role of organelles in the production and release of enzymes by animal cells.

Do **not** include details of transcription in your answer.

[5 marks]

Question 10 continues on the next page

Do not write outside the box

1 0 . 3 Describe the structure of ATP.

Outline how named enzymes break down and resynthesise ATP.

[4 marks]

15

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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

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