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I declare this is my own work.

AS

BIOLOGY

Paper 2

7401/2

Thursday 23 May 2024

Morning

Time allowed: 1 hour 30 minutes

At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.

[Turn over]



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MATERIALS

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 75.

DO NOT TURN OVER UNTIL TOLD TO DO SO



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Answer ALL questions in the spaces provided.

0 1 . 1

Water has a high heat capacity and a large latent heat of vaporisation.

Describe the importance of each of these properties to living organisms. [2 marks]

High heat capacity _____

Large latent heat of vaporisation _____

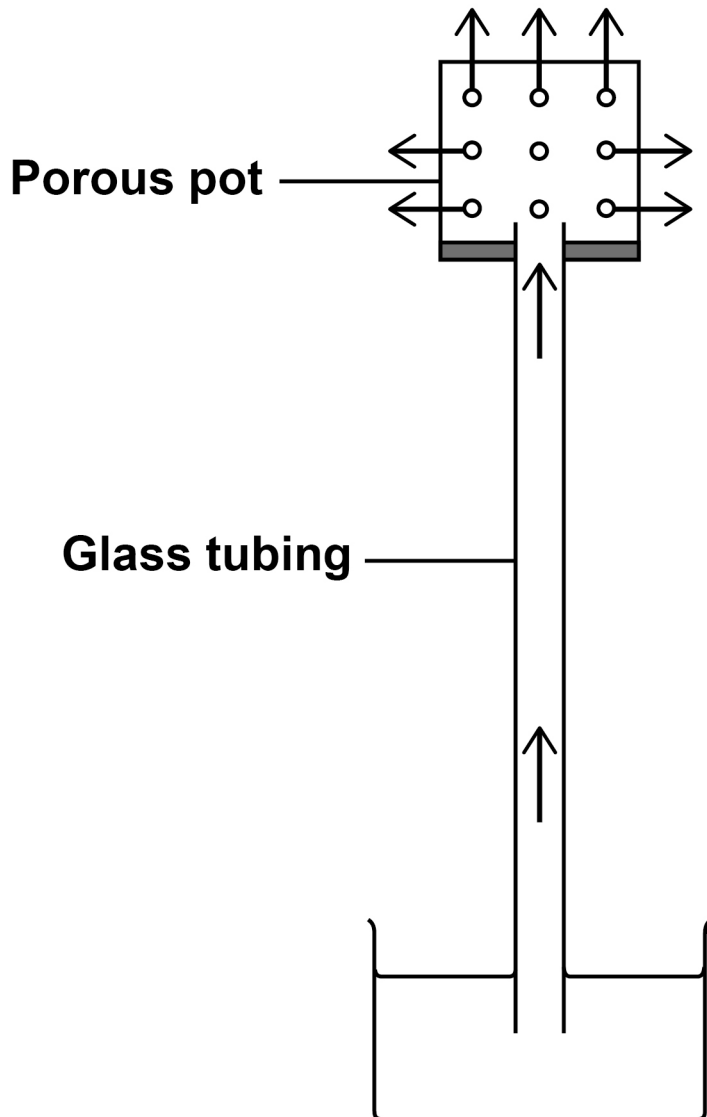
[Turn over]



01.2

FIGURE 1 shows that water loss from a porous pot can cause the upward movement of water.

FIGURE 1



KEY

→ Water movement





0	1	.	3
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An air bubble was introduced into the glass tubing in FIGURE 1, on page 6. The air bubble moved a distance (d) of 1.5 cm in 120 minutes. The radius of the lumen (hole) of the glass tubing was 0.6 cm

Use this information and the formula $\pi r^2 d$ to calculate the rate of water movement in the glass tubing in $\text{cm}^3 \text{ hour}^{-1}$.

Use $\pi = 3.14$ in your calculation. [1 mark]

Answer _____ $\text{cm}^3 \text{ hour}^{-1}$

[Turn over]

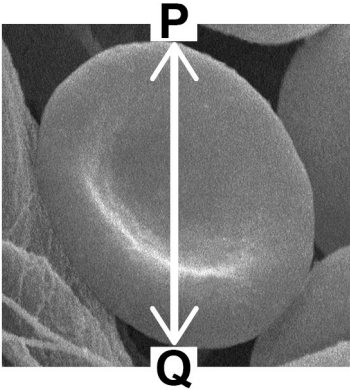
6



02.1

FIGURE 2 shows an image of a red blood cell at a magnification of $\times 5500$

FIGURE 2



Calculate the actual diameter in μm of the red blood cell between points P and Q.

Show your working. [2 marks]



Answer _____ μm

[Turn over]



0	2	.	2
---	---	---	---

A haemocytometer is a special microscope slide that can be used to determine the mean number of red blood cells in 0.004 mm^3 of blood.

- A researcher prepared a 10^{-3} dilution of a sample of blood from an adult.
- Using a haemocytometer, the researcher determined that the mean number of red blood cells in 0.004 mm^3 of the diluted blood sample was 21

The volume of blood in the body of the adult was 4.8 dm^3

Calculate the total number of red blood cells in the body of this adult.

Show your working. [2 marks]



Answer _____

[Turn over]



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02.4

There are four main blood groups in the human ABO blood group system.

TABLE 1 shows the basis on which each of these blood groups is classified.

TABLE 1

ABO blood group	Antigens present on red blood cells	Antibodies present in blood plasma
A	A	Anti-B
B	B	Anti-A
AB	A and B	No anti-A and no anti-B
O	No A and no B	Anti-A and anti-B

A transfusion of blood from a blood group A donor to a blood group B recipient would cause agglutination of the donated red blood cells.



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03.2

Mitochondrial respiratory capacity is a measure of maximum ATP production in a mitochondrion. Scientists investigated the effect of a resistance exercise training (RET) programme on the respiratory capacity of mitochondria in skeletal muscle tissue. RET develops muscle strength.

The scientists:

- **took samples of muscle tissue from 11 young males before and after a 12-week RET programme**
- **recorded the respiratory capacity of the mitochondria in the samples of muscle tissue.**

FIGURE 3, on page 22, shows some of the scientists' results.

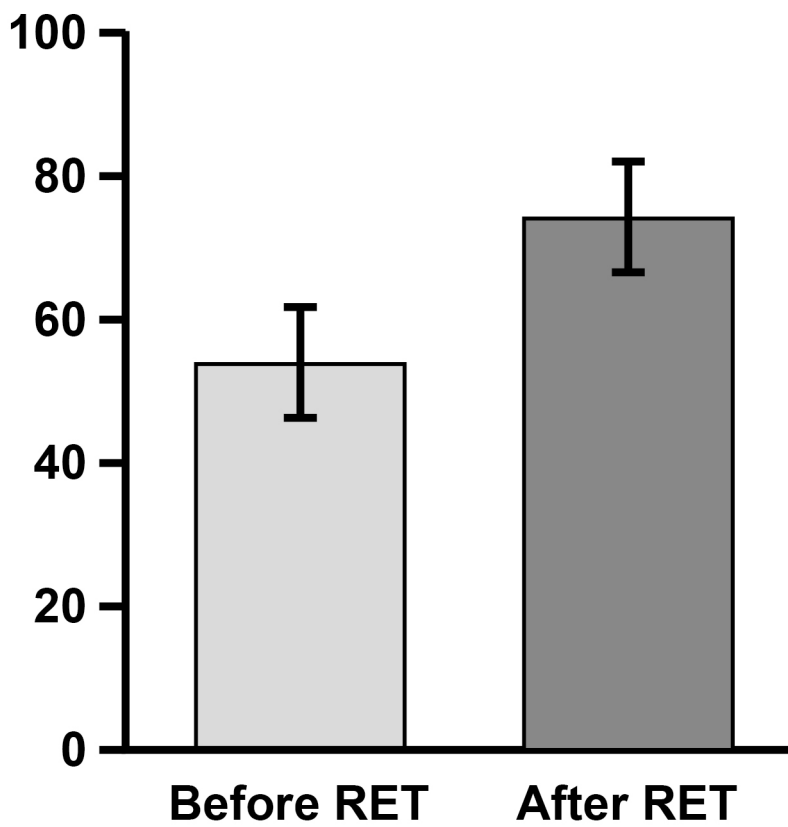
The error bars represent ± 2 standard deviations from the mean, which includes over 95% of the data.

[Turn over]



FIGURE 3

Mitochondrial
respiratory
capacity
per mg of
muscle tissue
/ arbitrary units



9



0 4 . 1

**Where does transcription occur in a eukaryotic cell?
[1 mark]**

0 4 . 2

The genome of an adenovirus is a single, linear molecule of double-stranded DNA. Adenoviruses use eukaryotic host cells to transcribe their genes in protein synthesis. The process of transcription of adenovirus genes is similar to the process of transcription of genes in eukaryotes.

Scientists investigated the process of transcription of this viral DNA.

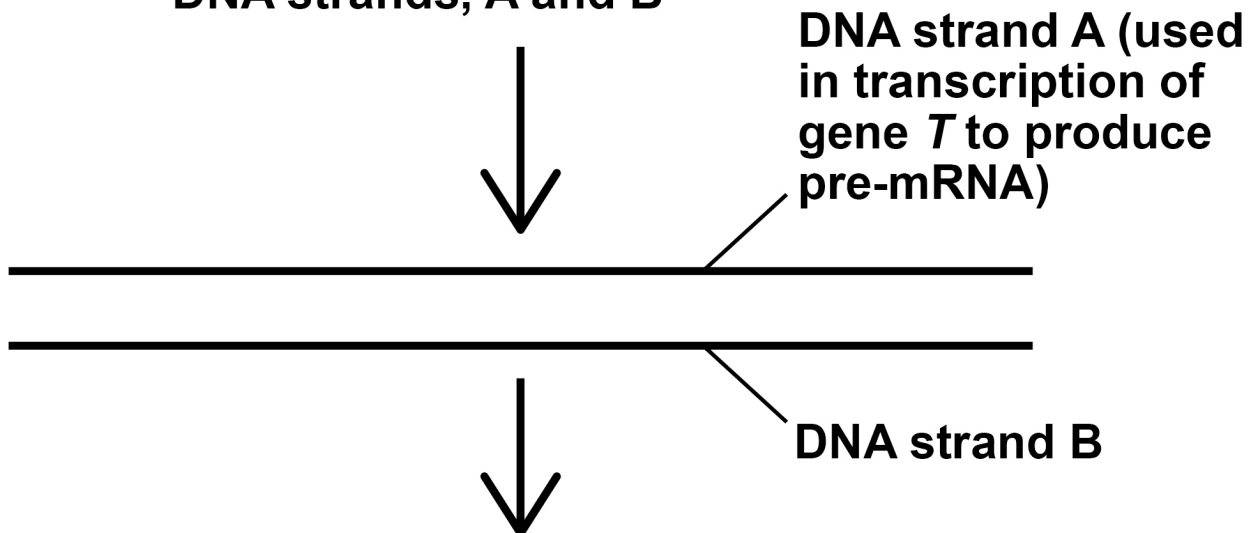
FIGURE 4, on page 26, shows one of the experiments carried out by these scientists.

[Turn over]



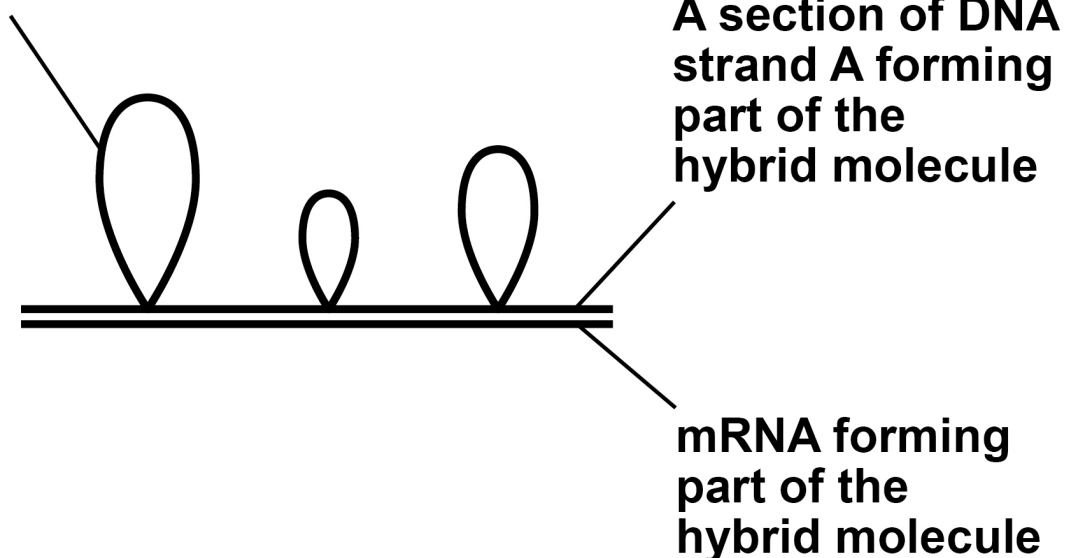
FIGURE 4

Gene *T* from an adenovirus was separated into two DNA strands, A and B



DNA strand A was then used to form a hybrid molecule with mRNA obtained from a eukaryotic host cell that had transcribed gene *T*

A loop of DNA strand A not forming part of the hybrid molecule



04.3

Describe and explain how the results of the experiment in FIGURE 4, on page 26, would differ if the scientists had used prokaryotic DNA. [2 marks]



0	4	.	4
---	---	---	---

Errors in the precise location of splicing in the DNA molecule can lead to mutations.

Explain why. [1 mark]

[Turn over]

7



0	5	.	2
---	---	---	---

Suggest ONE reason why analysing genes coding for ribosomal RNA allows phylogenetic relationships to be studied between all cellular organisms. [1 mark]

[Turn over]



0	5	.	3
---	---	---	---

Most orchid species are found in tropical rainforests. Two common features found in many of these species are:

- **they grow up trees to reach the upper branches**
- **they only open their stomata at night.**

Suggest how each of these TWO features benefits these orchids. [2 marks]

They can reach the upper branches of trees

They only open their stomata at night



05.5

The student produced a biological drawing of the leaf tissue they viewed through an optical microscope.

Give **THREE** ways the student could ensure they produce a correct biological drawing of the leaf tissue.

Assume the student uses a sharp pencil. [3 marks]

1

2



3

[Turn over]

10



06.1

Disinfectants are used to kill microorganisms on non-living surfaces. A student investigated the effect of different concentrations of disinfectant X on the growth of 'Bacillus subtilis'.

The student:

- **added 5 cm³ of a different concentration of disinfectant X to 5 different test tubes**
- **added 5 cm³ of distilled water to another test tube**
- **added 2 cm³ of a culture of 'B. subtilis' to all 6 test tubes**
- **incubated the test tubes at 25 °C for 24 hours**
- **used a colorimeter to record the percentage of light absorbed by the contents of each tube.**

TABLE 2, on the opposite page, shows the student's results.



TABLE 2

Percentage concentration of disinfectant X	0	20	40	60	80	100
Percentage light absorbance	100	100	87	52	10	10

The student prepared the different concentrations of disinfectant X.

Describe how the student made 5 cm³ of the 60% concentration using distilled water and undiluted disinfectant. [1 mark]

[Turn over]



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0	6	.	2
---	---	---	---

The student used a sterile pipette with 0.1 cm^3 graduations to transfer 2 cm^3 of 'B. subtilis' into each test tube.

What is the uncertainty in measuring 2 cm^3 with this pipette?

Calculate the percentage uncertainty of this 2 cm^3 measurement. [2 marks]

Uncertainty _____ cm^3

Percentage uncertainty _____

[Turn over]



REPEAT OF TABLE 2

Percentage concentration of disinfectant x	0	20	40	60	80	100
Percentage light absorbance	100	100	87	52	10	10

06.3

Use TABLE 2 to evaluate the effectiveness of disinfectant X at killing microorganisms on non-living surfaces. [4 marks]



0	7	.	3
---	---	---	---

Mosaic trisomy 18 is another type of Edwards' syndrome. This occurs due to a chromosome mutation after fertilisation.

In mosaic trisomy, the body has cells with an extra chromosome 18 AND cells with the correct number of chromosomes.

**Explain how cells with different numbers of chromosomes are produced in mosaic trisomy.
[1 mark]**



0	7	.	4
---	---	---	---

The age of the female parent is a factor linked to the risk of a child having Edwards' syndrome.

Which statistical test should be used to test whether this link is statistically significant? [1 mark]

Tick (✓) ONE box.

Correlation coefficient

Chi-squared

Student's t-test

[Turn over]



[Turn over]

8



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0	8
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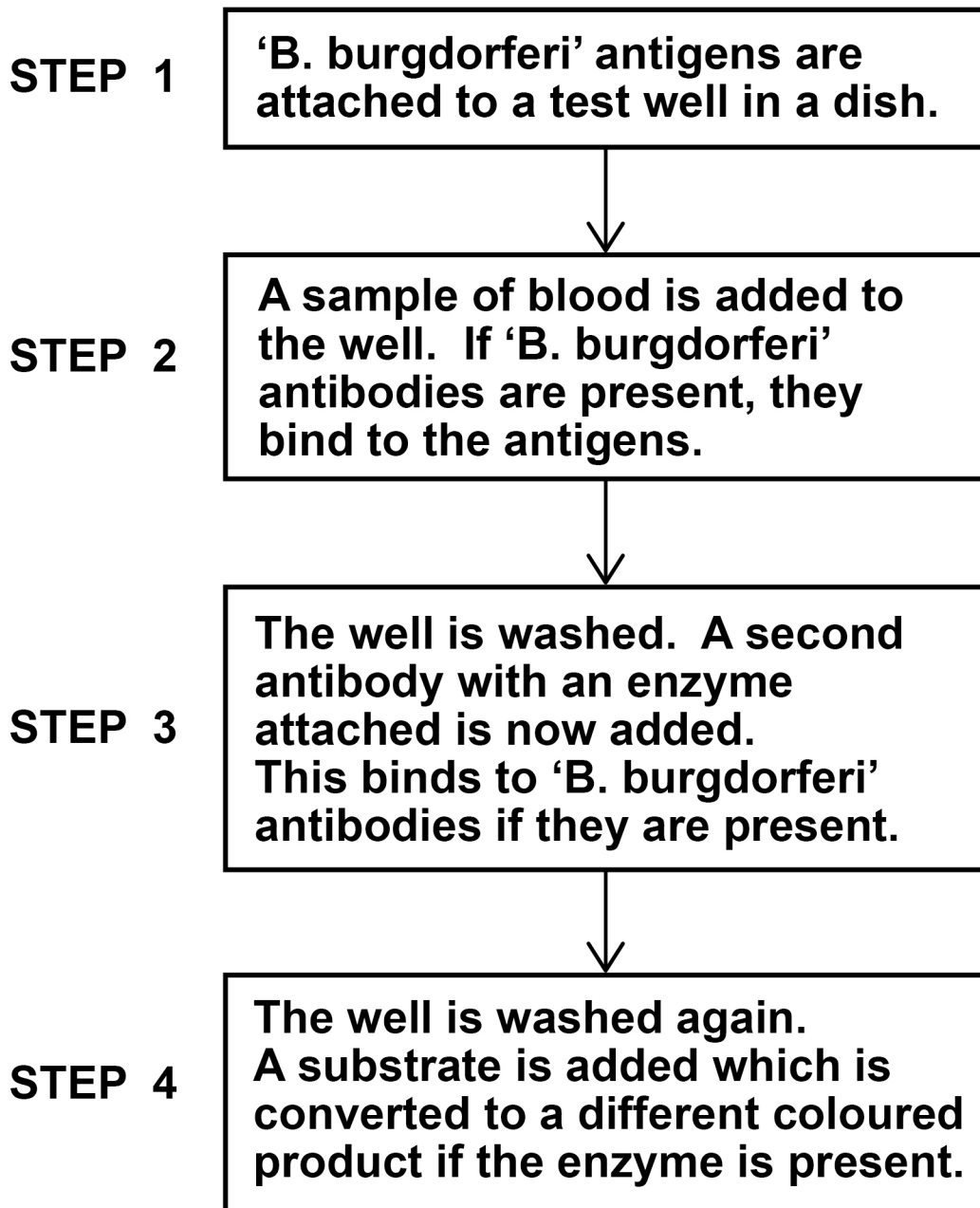
Lyme disease is most frequently caused by the bacterium 'Borrelia burgdorferi'. Lyme disease can be difficult to diagnose.

FIGURE 5, on page 50, shows an ELISA test that is used to find out if a person has antibodies to 'B. burgdorferi'.

[Turn over]



FIGURE 5



A false positive in this test is a result which incorrectly indicates that antibodies to 'B. burgdorferi' are present.



08.1

Failure to thoroughly wash the well in STEP 4 can result in a false positive.

Explain why. [2 marks]

[Turn over]

0	8	.	2
---	---	---	---

A false positive can be produced if a person has been infected by another bacterium that causes a disease called syphilis.

Suggest why. [1 mark]



0	8	.	3
---	---	---	---

A false NEGATIVE in this test is often produced if a person is tested within 2 weeks of being infected with 'B. burgdorferi'.

Explain why. [2 marks]

[Turn over]





08 . 4

Sometimes, symptoms of Lyme disease can persist for 6 months following antibiotic treatment. This condition is known as Post-Treatment Lyme Disease Syndrome (PTLDS).

Scientists investigated the symptoms experienced by a large number of PTLDS patients and a control group. During a 2-week period, they asked all the participants:

- if they had experienced symptoms of PTLDS
- to record the intensity of these symptoms.

The scientists used a statistical test to determine if there was a difference in the intensity of symptoms of PTLDS between these two groups.



TABLE 3 shows some of the scientists' results, including the probability (P) values obtained using the statistical test.

TABLE 3

SYMPTOM	Percentage of PTLDS group experiencing symptom	Percentage of control group experiencing symptom	P value for difference in the intensity of symptoms
Fatigue	100	57	<0.001
Joint pain	96	32	<0.001
Depression	40	4	<0.005
Fever	35	3	<0.005
Muscle pain	86	62	<0.001

[Turn over]



The scientists concluded that more PTLDS patients than the control group experienced:

- **symptoms**
- **greater intensity of symptoms.**

Evaluate the scientists' conclusions. [4 marks]

9

[Turn over]



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Question	Mark
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TOTAL	

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