

Cells – AS Biology P2

1. No.1

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.

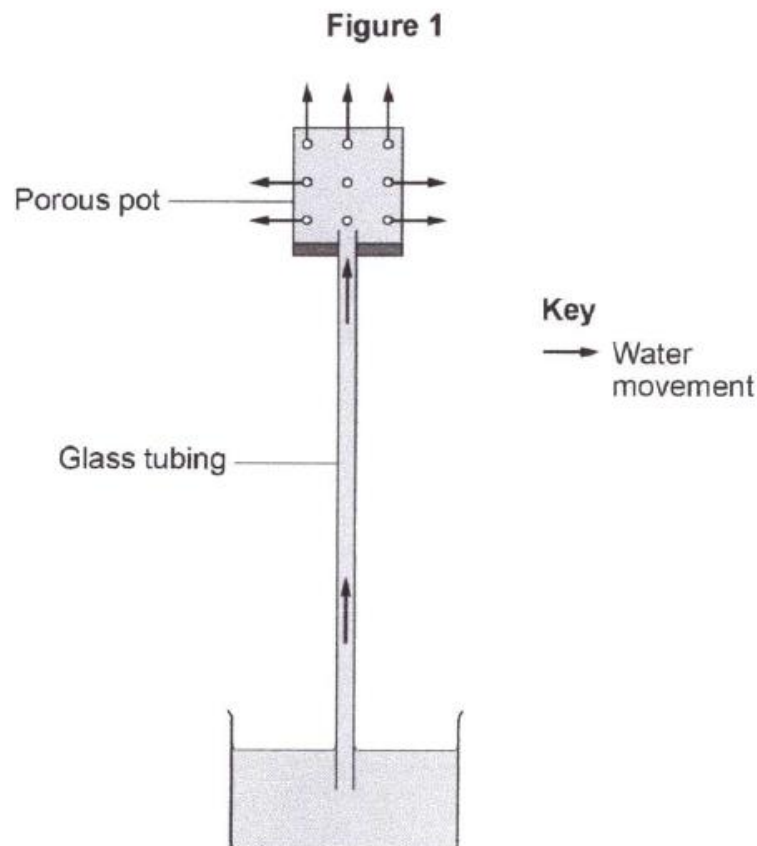
[2 marks]

High heat capacity Buffers changes in temperature, helping maintain a stable internal environment.

Large latent heat of vaporisation Provides a cooling effect via evaporation allowing organisms to lose excess heat

0 1 . 2

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



Biologists have concluded that the experiment in **Figure 1** supports the cohesion–tension theory of water transport in the xylem.

Explain how this conclusion is supported by the experiment in **Figure 1**.

[3 marks]

Water evaporates from the porous pot, stimulating transpiration. This creates tension, pulling water up through a glass tubing. Cohesion between water molecules due to hydrogen bonding, maintains a continuous water column.

0 1 3

An air bubble was introduced into the glass tubing in **Figure 1**. 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.

$$\begin{aligned} \text{Volume} &= \pi r^2 d \\ &= 3.14 \times (0.6)^2 \times 1.5 \\ &= 1.6956 \text{ cm}^3 \\ \text{Rate} &= \frac{\text{cm}^3}{\text{hours}} \end{aligned}$$

$$\begin{aligned} \text{Rate} &= \frac{1.6956 \text{ cm}^3}{2 \text{ hours}} \\ &= 0.8478 \text{ cm}^3/\text{h} \end{aligned} \quad [1 \text{ mark}]$$

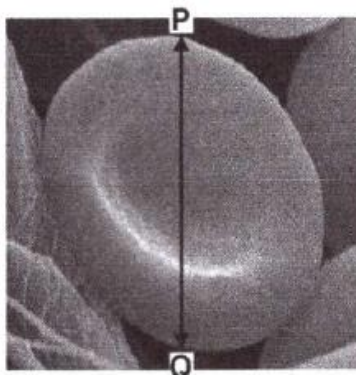
Answer 0.85 $\text{cm}^3 \text{ hour}^{-1}$

2. No.2

0 2 . 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.

$$PQ = 40 \text{ mm.}$$

$$\begin{aligned} \text{Actual length} &= \frac{40}{5500} \\ &= 7.2727 \times 10^{-3} \end{aligned}$$

$$\begin{aligned} 7.3 \times 10^{-3} \times \\ 1000 \\ = 7.3 \end{aligned}$$

[2 marks]

Answer 7.3 μm

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.

Undiluted blood
 $21 \times 10^3 = 21000 \text{ RBC per } 0.004 \text{ mm}^3$

RBC per mm^3 .

$$\frac{21000}{0.004} = 5250000 \text{ RBC/mm}^3$$

$$4.8 \text{ m}^3 = 4.8 \times 10^6 \text{ mm}^3$$

Total number of RBCs [2 marks]
 $5.25 \times 10^6 \times 4.8 \times 10^6$
 $= 25.2 \times 10^{12}$
 2.52×10^{13}

Answer $2.52 \times 10^{13} \text{ RBC}$

0 2 . 3

The solution used to dilute the blood had to have the same water potential as the blood.

Explain why.

[2 marks]

Osmosis does not occur because of same water potential. Therefore, the Red blood cells do not burst.

0 2 . 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.

Use information in **Table 1** to explain why.

[2 marks]

RBCs from group A have A antigens which bind with anti-A antibodies present in plasma of Group B recipient. This antigen-antibody reaction causes agglutination of red blood cells which can block blood vessels.

0 2 . 5

Using **Table 1**, give the blood groups of people who could accept a donation of blood group **O** without causing agglutination of the **donated** red blood cells.

[1 mark]

Blood groups A, B, AB and O.

3. No.4

0 4 . 1

Where does transcription occur in a eukaryotic cell?

[1 mark]

Nucleus.

0 4 . 2

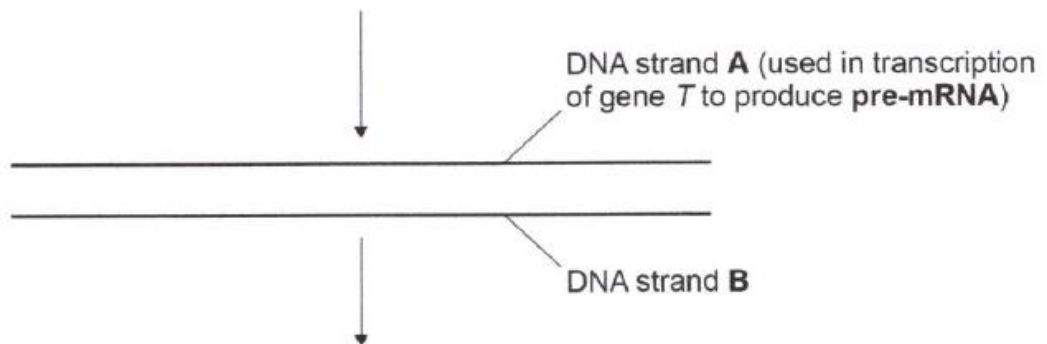
The genome of an adenovirus is a single, linear molecule of double-stranded DNA. Adenoviruses use eukaryotic host cells to transcribe their genes in protein synthesis. The process of transcription of adenovirus genes is similar to the process of transcription of genes in eukaryotes.

Scientists investigated the process of transcription of this viral DNA.

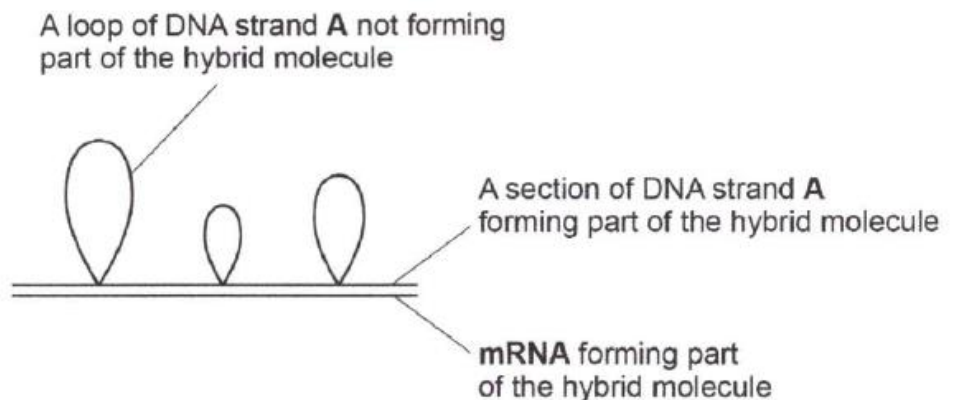
Figure 4 shows one of the experiments carried out by these scientists.

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*



Looking at the results of the experiment in **Figure 4**, the scientists concluded that splicing had taken place.

Use **Figure 4** to describe and explain why the scientists' conclusion was justified.

[3 marks]

Loops of DNA that don't pair with mRNA represent introns which are not present in mature mRNA.

Only section of DNA strand A that forms hybrid with mRNA are complementary showing that they are exons retained in the final mRNA transcript. This shows that splicing occurred where introns were removed and exons were joined to form mature mRNA.

0 4 . 3

Describe and explain how the results of the experiment in **Figure 4** would differ if the scientists had used prokaryotic DNA.

[2 marks]

There would be no loops of DNA observed in hybrid molecules because prokaryotic DNA does not contain introns that need to be removed by splicing.

0 4 . 4

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

Explain why.

[1 mark]

Can cause deletion of exons which could alter the sequence of bases in the mRNA.

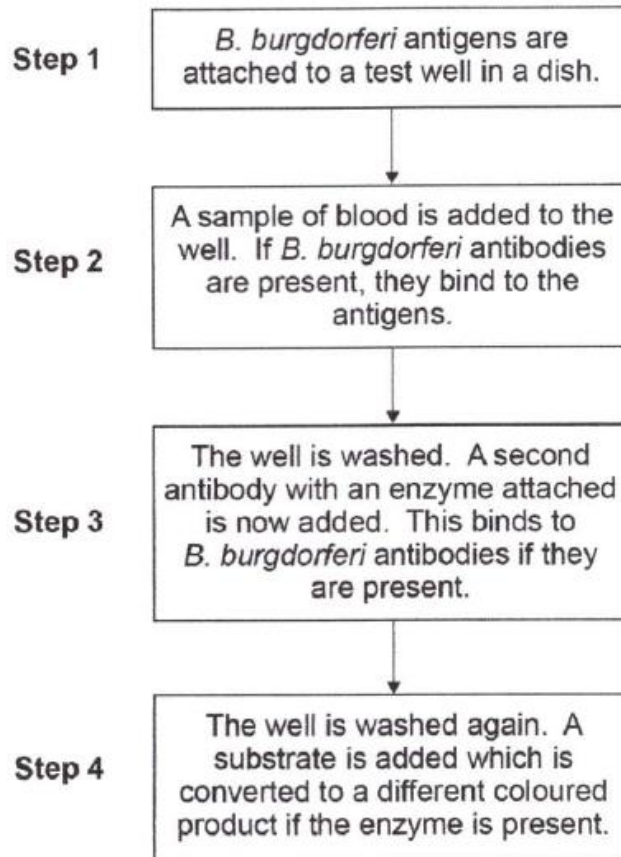
4. No.8

0 8

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

Figure 5 shows an ELISA test that is used to find out if a person has antibodies to *B. burgdorferi*.

Figure 5



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

0 8 . 1

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

Explain why.

[2 marks]

The second antibody with the enzyme may remain in the well even if no antibodies to *B. burgdorferi* are present. This would lead to the substrate being broken down into a coloured product giving a false positive result.

08.2

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]

Antibodies produced against syphilis are similar in shape to those produced against *B. burgdorferi*, so they bind to the same antigen

08.3

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]

Low concentration of antibodies against *B. burgdorferi* (within first two weeks). Because only the primary immune response has started.

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

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

- symptoms
- greater intensity of symptoms.

Evaluate the scientists' conclusions.

[4 marks]

For all symptoms a higher percentage of PTLDS group experienced symptoms than control groups.
 All P values are below 0.005 indicating statistically significant difference in symptom intensity between groups.
 Fatigue, joint pain and muscle pain show the highest difference suggesting these symptoms especially support the claim.
 The study only covered a 2-week period which is a shorter time frame for chronic condition.