

Genetic information, variation and relationships between organisms – AS Biology P1

1. No.3

03.1

Describe how viruses are replicated.

[4 marks]

Viruses attach to the host cell using its attachment proteins which bind to specific receptors proteins on the host cell surface.

The viral nucleic acid is then injected to host cells. Inside the host cell the viral nucleic acid is replicated. In RNA viruses like HIV, reverse transcriptase converts RNA into DNA.

The host cell uses its machinery to synthesize viral proteins from the viral genetic material.

The viral components are assembled into new virus particles which are released from the host cell.

03.2

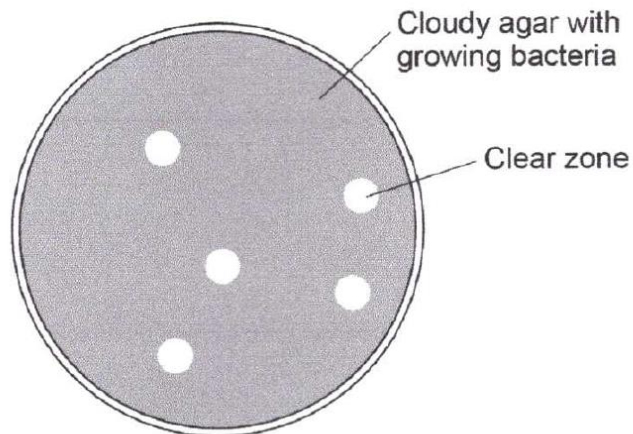
A scientist investigated the effect of a virus species on a bacterial culture.

The scientist:

- mixed a diluted sample of the virus with a bacterial culture in liquid agar
- poured the liquid agar into a Petri dish and let the agar set
- incubated the virus-bacterial culture at 30 °C for 24 hours.

Figure 3 shows the appearance of the Petri dish after 24 hours.

Figure 3



Explain why clear zones are present in Figure 3.

[1 mark]

Virus replication has killed cells in the clear zones.

03.3

Predict the appearance of the Petri dish if the incubation was extended by a few more hours.

[1 mark]

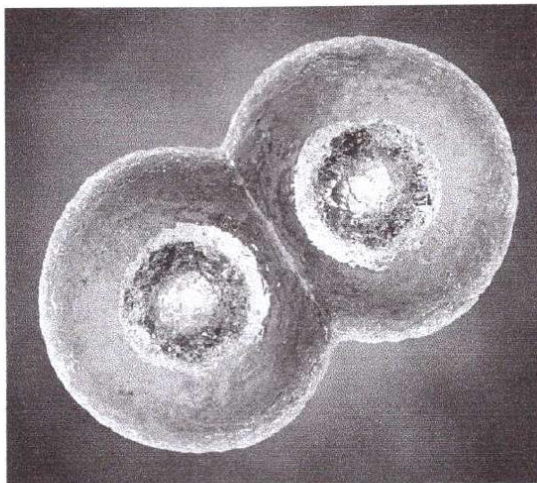
More clear zones will form.

0 3 4

Animal cells replicate during the cell cycle.

Figure 4 shows one animal cell at a stage of the cell cycle.

Figure 4



Identify the stage of the cell cycle shown in Figure 4.

Explain the appearance of the cell shown in Figure 4.

Do **not** refer to organelles in your answer.

[2 marks]

Identity of stage Telophase.Explanation A new cell surface membrane is forming

2. No.4

0 4 . 1

Complete Table 3 to show whether the feature of DNA is associated with the DNA molecule found in each of these locations.

Tick (✓) the appropriate boxes.

[3 marks]

Table 3

Feature of DNA	Location of DNA molecule		
	Prokaryotic cell	Nucleus	Chloroplast
Is circular	✓		✓
Contains four different types of nucleotide	✓	✓	✓
Is associated with histones		✓	

Some strains of the bacterium, *Escherichia coli*, are known to be resistant to antibiotics.

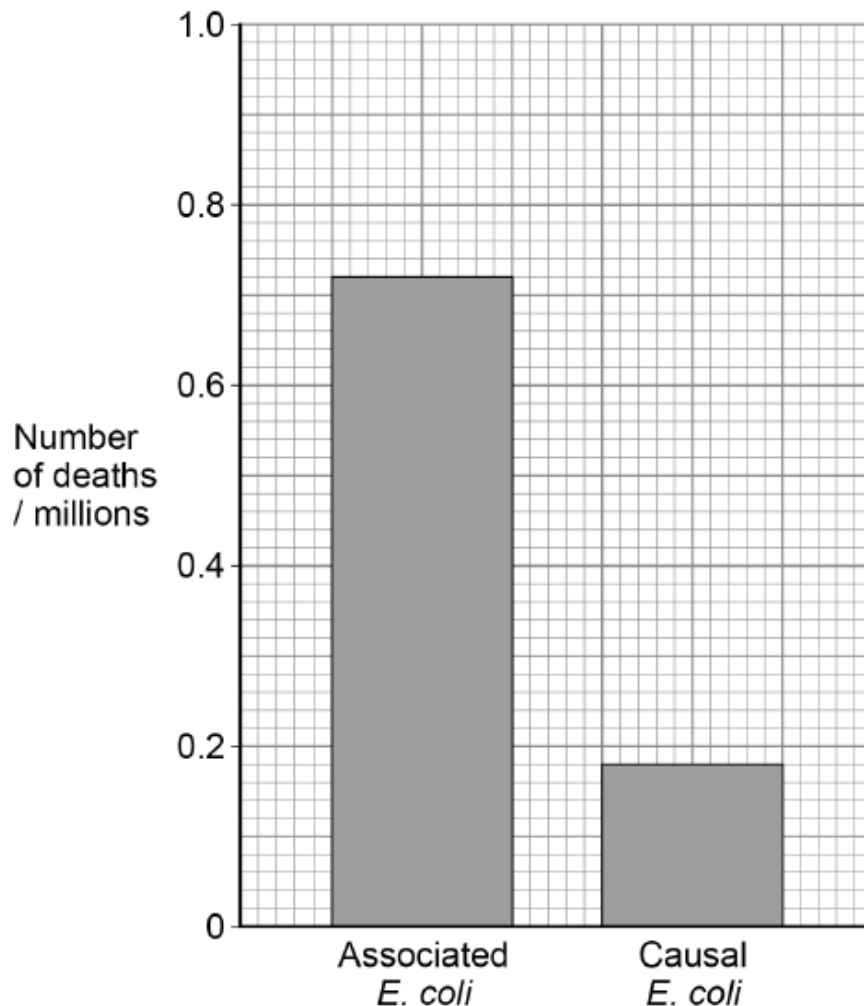
Scientists analysed data recording the deaths of people in hospitals across the world during 2019.

They used the data to find how many of the bodies of people who died in hospitals contained antibiotic-resistant *E. coli* bacteria and whether the *E. coli* were:

- not the cause of death (**associated *E. coli***)
- the cause of death (**causal *E. coli***).

Figure 5 shows their results.

Figure 5



0 4 . 2

Using **Figure 5**, a student calculated that out of all the people who died when antibiotic-resistant *E. coli* were present, 25% of those deaths involved **causal** *E. coli*.

The student's calculation is **incorrect**.

Use **Figure 5** to calculate the correct percentage of deaths involving **causal** *E. coli* in people who died when infected with antibiotic-resistant *E. coli*.

Identify the mathematical step the student performed incorrectly in their calculation.

[3 marks]

$$\begin{array}{l|l}
 \text{Casual } E. coli \text{ deaths} & \text{Total deaths} = 0.18 + 0.72 \\
 = 0.18 \approx 180000 & = 0.90 \\
 \text{Associated } E. coli & \% \text{ Casual} = \frac{0.18}{0.9} \times 100 = 20\% \\
 = 0.72 \approx 720000 &
 \end{array}$$

Correct answer 20 %

Incorrect mathematical step Used 0.72 as the denominator
not 0.9.

0 4 . 3

Which method is most likely to be successful in **decreasing** the frequency of antibiotic-resistant bacteria in populations of people?

Tick (✓) **one** box.

[1 mark]

Give people lower doses of antibiotics to treat disease.

☐

Test more people to determine if they are infected with antibiotic-resistant bacteria.

☐

Vaccinate more people to reach herd immunity against bacteria that cause diseases common in human populations.

☒

3. No.5

0 5 . 1

Malva sylvestris is a plant species.

A student wanted to determine the mean height of *M. sylvestris* plants growing in a field.

Describe how the student should obtain measurements of the plants and then process these measurements to obtain a reliable mean height of plants growing in that field.

[5 marks]

The student should place a grid over the field.

They should use a method of random sampling such as generating random coordinates using a calculator or table of random numbers.

For each plant sampled, the student must use the same number of measurement.

The student should measure a large number of plants to improve reliability and reduce the effect of anomalies.

To calculate the mean, the student should add all the heights together and divide by the total number of plants measured.

0 5 . 2

The student wanted to present the results for the distribution of plant heights in a histogram.

Figure 6 shows the outline of a results table.

Use Figure 6 to design a suitable results table the student should use for a histogram of plant height measurements ranging between 60 cm and 120 cm.

[2 marks]

Figure 6

Plant height / cm	Frequency
$60 \leq x < 70$	
$70 \leq x < 80$	
$80 \leq x < 90$	
$90 \leq x < 100$	
$100 \leq x < 110$	
$110 \leq x < 120$	

0 5 . 3

A student investigated biodiversity in a community of bee species in a field of wild flowers.

The student trapped and identified the bee species in the field over 6 months.

Table 4 shows some of the student's results.

Table 4

Bee species	Total number of trapped bees after 6 months
Cuckoo bee	250
Domestic honeybee	800
Clover bee	200

The index of diversity in a community of organisms is determined using the formula

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

where N = total number of organisms of all species
and n = total number of organisms of each species.

Use the formula and information in Table 4 to calculate the index of diversity in this community of bee species.

[2 marks]

$$N = 250 + 800 + 200$$

$$= 1250$$

$$N(N-1)$$

$$= 1250 \times 1249 =$$

$$= 1,561,250$$

$$\sum n(n-1)$$

$$= 250(249) + 800(799) + 200(199)$$

$$250 \times 249 = 62,250$$

$$800 \times 799 = 639,200$$

$$200 \times 199 = 39,800$$

$$\sum n(n-1)$$

$$62,250 + 639,200 + 39,800$$

$$= 741,250$$

$$d = \frac{1,561,250}{741,250}$$

$$= 2.11$$

Answer

2.11

0 5 . 4

In a different investigation, the student found that:

- the species richness of plants in a field of wild flowers is greater than the species richness of plants in a field of wheat
- the species richness of **bees** in a field of wild flowers is greater than the species richness of **bees** in a field of wheat.

Suggest **one** reason why the species richness of bees in a field of wild flowers is greater than the species richness of bees in a field of wheat.

Explain your answer.

[2 marks]

There are more plant species in the field of wild flowers. So there is a greater variety of food source and habitats for different bee species allowing more species of bees to coexist.

4. No.6

0 6 . 1

Give two roles of phosphate ions in cells.

[2 marks]

- 1 Phosphate ions are a component of DNA and RNA forming part of the sugar phosphate backbone.
- 2 Phosphate ions are used to produce ATP, which is the main energy carrying molecule in cells.

0 6 . 2

Diseased lungs can cause carbon dioxide to build up in the blood plasma. This leads to an increase in hydrogen ion concentration in the plasma.

Describe the effect this increase in hydrogen ion concentration has on the plasma and on the proteins in the plasma.

Do not refer to the Bohr effect.

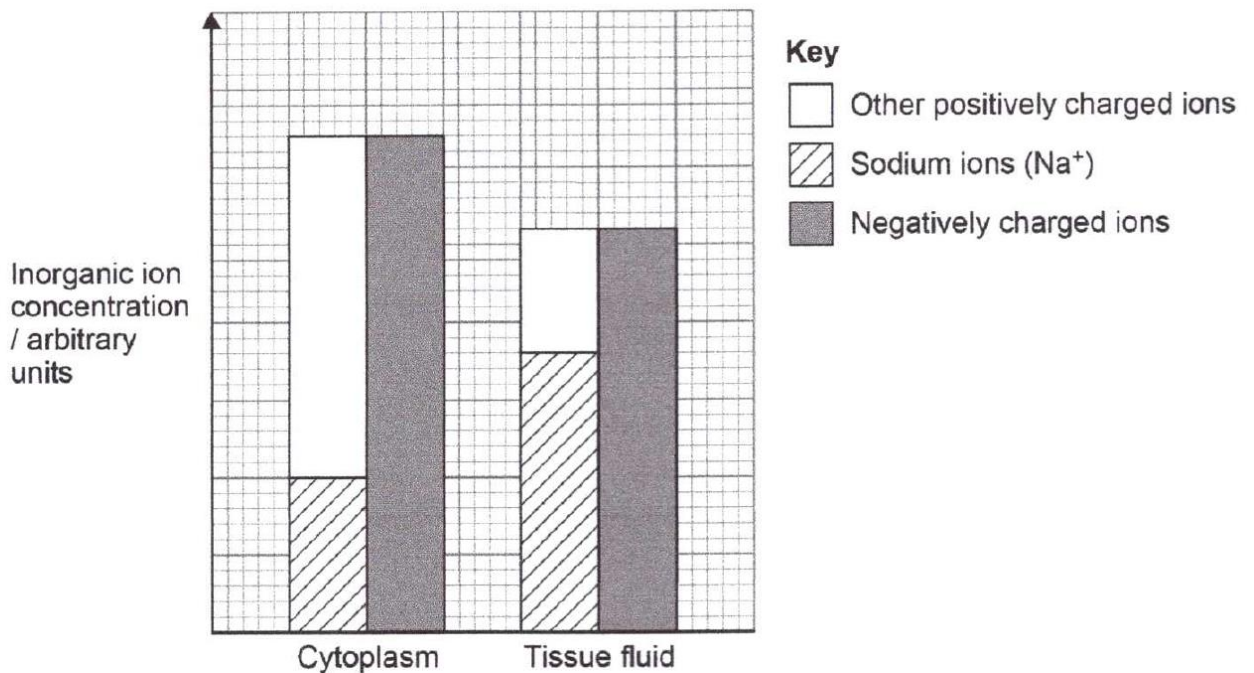
[2 marks]

Increase in hydrogen ion concentration causes decreased plasma pH. This can denature proteins in the plasma or alter their tertiary structure including changing the shape of active site which affects their function.

Scientists measured the concentration of inorganic ions in the cytoplasm of mammalian cells and in the tissue fluid surrounding those cells.

Figure 7 shows their results.

Figure 7



0 6 . 3

Use **Figure 7** to describe **two** patterns shown in the **total** concentrations of positively and negatively charged ions in the cytoplasm and in tissue fluid.

[2 marks]

1 There is equal positive and negative in both cytoplasm and tissue fluid.

2 There is a higher ion concentration in cytoplasm compared to tissue fluid.

06.4

In these mammalian cells, the:

- cell-surface membrane is permeable to sodium ions
- sodium ion concentration does not increase in the cytoplasm over time.

Use this information and **Figure 7** to suggest and explain the ion transport mechanisms involved in the transport of sodium ions.

[2 marks]

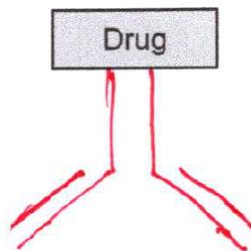
- Sodium ions move in to the cells by facilitated diffusion down a concentration gradient.

- Sodium ions move out of cells by active transport against a concentration gradient.

5. No.7

07.1

A drug is delivered to diseased body cells by a monoclonal antibody. The monoclonal antibody is attached to a drug to form an antibody–drug complex (ADC).

Figure 8

Complete **Figure 8** to show a monoclonal antibody attached to the drug.

Label **one** structural feature of the monoclonal antibody in your drawing of the ADC.

[2 marks]

07.2

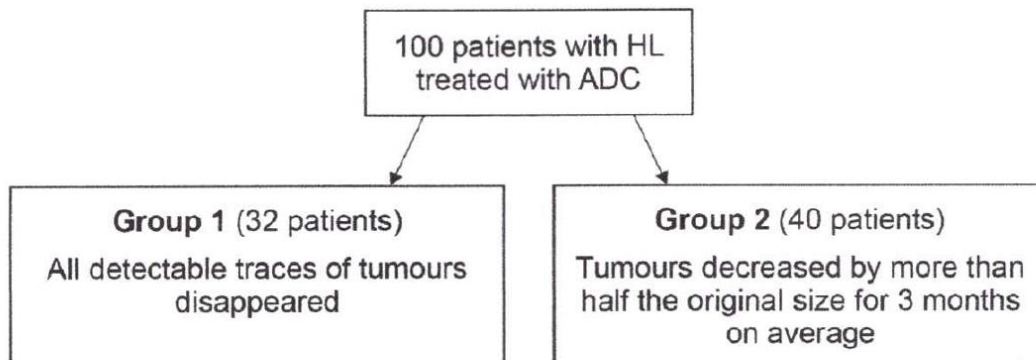
Scientists used a clinical trial to test an ADC designed to treat people diagnosed with the cancer, Hodgkin lymphoma (HL).

In the clinical trial, the patients with HL:

- were selected at random
- had tumours of a similar size at the start of the trial
- received identical doses of the ADC.

Figure 9 shows some of the results from the clinical trial.

Figure 9



Use all the information to evaluate the effectiveness of the ADC in treating people with HL.

Do **not** refer to statistical tests in your answer.

[4 marks]

ADC was effective in curing cancer in 32 patients where the tumour were completely removed. It also reduced the size of tumours in 40 patients showing a total positive response in 72 out of 100 patients suggesting good effectiveness overall. However its effect is unknown in 28 patients indicating ADC may not work for everyone. There is no information beyond 3 months so it is hard to tell whether the tumours will continue shrinking or stay the same or even regrow. The sample size is small, which limits how generalisable the findings are to a larger population.

6. No.9

0 9

Read the following passage.

DNA is a stable molecule but, even under normal cell conditions, spontaneous changes occur to the DNA nucleotide sequence. One example of a spontaneous change occurs when a cytosine base in a guanine–cytosine nucleotide pair is changed to a uracil base. This produces a guanine–uracil nucleotide pair in the DNA molecule. Scientists estimate this type of spontaneous change occurs to 100 guanine–cytosine nucleotide pairs in the genome of healthy human cells every day.

5

In healthy cells, enzyme-controlled processes repair these spontaneous changes in the DNA molecule by changing uracil bases back to cytosine bases. If these repairs do **not** happen, the uracil DNA nucleotide attracts an adenine DNA nucleotide when the DNA is replicated in the cell cycle. A mutation of the original DNA has now occurred.

10

Healthy cells with damaged DNA produce enzyme X. This enzyme slows the cell cycle by delaying the start of DNA replication. People with the disease ataxia telangiectasia (AT) do not produce functional enzyme X. Mutations occur at a higher rate in people with AT.

15

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

0 9 . 1

Give **one** similarity in structure between a guanine–cytosine nucleotide pair and a guanine–uracil nucleotide pair in a DNA molecule (lines 3–5).

Do **not** refer to guanine in your answer.

[1 mark]

It has a phosphate group.

09.2

The DNA in a human genome contained 3×10^9 nucleotide pairs.

Assume 40% of these nucleotide pairs are guanine–cytosine nucleotide pairs.

Use this information and lines 5–7 to calculate the percentage of guanine–cytosine nucleotide pairs that change to guanine–uracil nucleotide pairs in this genome every day.

Give your answer in standard form.

Show your working.

$$\begin{aligned} \text{Total number of nucleotide pairs} &= 3 \times 10^9 \\ 40\% \text{ of G-C pairs} & \\ 40\% \text{ of } 3 \times 10^9 & \\ 0.4 \times 3 \times 10^9 & \\ &= 1.2 \times 10^9 \end{aligned}$$

Fraction that change daily.

[2 marks]

$$\frac{10,000}{1.2 \times 10^9} = \frac{1 \times 10^4}{1.2 \times 10^9} = 8.3 \times 10^{-6}$$

Answer $8.3 \times 10^{-6}\%$

09.3

The type of mutation that occurs when 'repairs do not happen' (lines 10–11) may still produce a functional protein.

Suggest and explain why.

[4 marks]

This type of mutation may be substitution mutation. This type of mutation changes only one base pair/triplet in the gene. However the same amino acid may still be coded for. Because the genetic code is degenerate, meaning more than one triplet can code for the same amino acid.

09.4

Suggest and explain why 'mutations occur at a higher rate' in people with AT (lines 15–16).

[3 marks]

People with AT have no functional enzyme (eg enzyme X) so the cell cycle is not delayed. Therefore DNA is replicated more often, or replication could be unchecked increasing chances of mutations during DNA replication.