Algebra and Equations (Maths Skills MS2): Edexcel SNAB A Level Biology Exam Questions

20 questions · 49 marks · about 59 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · AS Paper 1 · June 2019 · Q4(c)(ii) · 2 marks

(ii) A six-year-old child can be classified as obese based on their body mass index (BMI) being over 19 kg m^{-2}.

BMI is calculated using the following formula.

$$\text{Body mass index (BMI)} = \frac{\text{body mass}}{\text{height}^2}$$

A six-year-old child is 115 cm tall with a BMI of 20.

Calculate the mass of this child to one decimal place.

(2)

Answer .....

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7 Obesity indicators, such as body mass index (BMI), can be used to assess the risk of a person developing coronary heart disease (CHD).

(a) The table shows categories of BMI.

BMI	Classification
Less than 20	underweight
20–24.9	normal
25–29.9	overweight
30–40	obese
Greater than 40	severely obese

A man has a body mass of 65 kg.

He has a normal BMI.

Calculate the minimum and maximum possible heights for this man in metres.

Use the formula

$$\text{BMI} = \frac{\text{mass}}{(\text{height in m})^2}$$

(2)

minimum height ..... m

maximum height ..... m

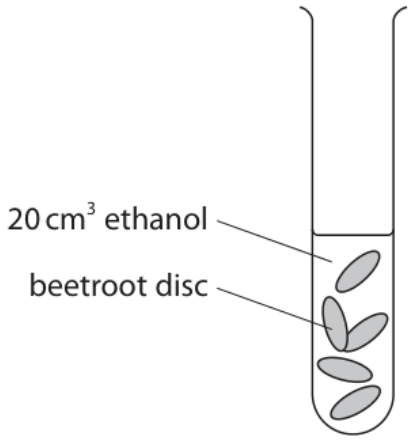
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Question 3 · AS Paper 1 · June 2023 · Q8(c)(i) · 2 marks

(c) Beetroot cell vacuoles contain a red pigment called betalain.

A student investigated the effect of ethanol on the permeability of beetroot membranes.

Test tubes were set up as shown in the diagram, each with a different concentration of ethanol.



The test tubes were placed in a thermostatically controlled water bath at 25 °C for 30 minutes.

The beetroot discs were removed from the ethanol.

(i) Calculate the volume of a beetroot disc with a diameter of 1 cm and a height of 5 mm to **one** decimal place.
Include the appropriate unit.

Use the formula $V = \pi r^2 h$

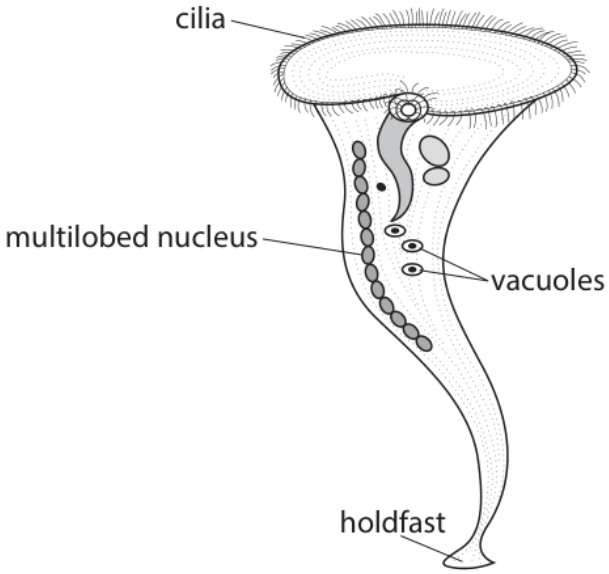
(2)

Answer .....

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2 *Stentor coeruleus* is a unicellular organism.

The drawing shows the structure of a *Stentor coeruleus*.



(a) This *Stentor* has a height of 1 mm and a diameter of 0.4 mm at the top.

(i) Calculate the volume of this cone-shaped *Stentor*.

Use the equation for the volume of a cone:

$$V = \pi r^2 \frac{h}{3}$$

Give your answer to three decimal places.

(2)

..... mm^3

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Question 5 · A level Paper 1 · June 2025 · Q9(b) · 3 marks

(b) Trees are important carbon sinks.

A formula can be used to calculate the mass of carbon in the trunk of a tree:

Biomass = volume of trunk × density of the species

The mass of carbon stored in the trunk is 50% of the biomass.

Calculate the mass of carbon stored in the trunk of an oak tree with a height of 3.0 m and a diameter of 1.2 m.

The density of oak is 720 kg m^{-3}.

Volume of a cylinder = $\pi r^2 h$

Give your answer to one decimal place.

(3)

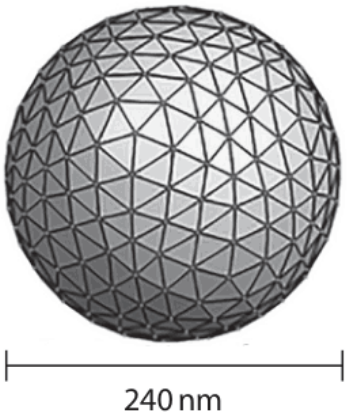
Answer ..... kg

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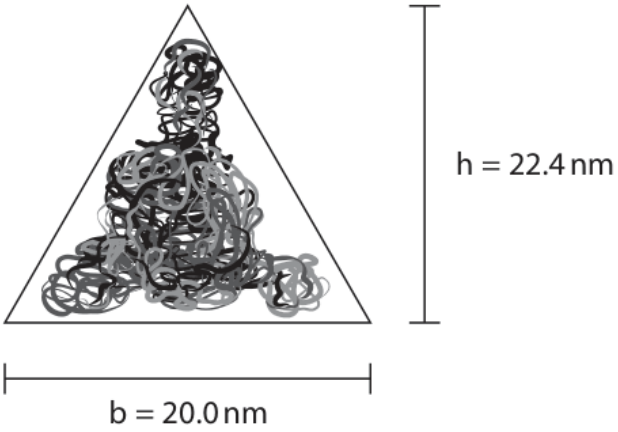
(b) The surface of this virus capsid is covered with 'spike' proteins.

The diameter of the capsid of this virus is 240 nm.

Diagram of the surface of the virus showing each spike protein as a triangle



The diagram shows the area occupied by one spike protein



Calculate the maximum number of spike proteins that can be packed on the surface of one virus particle.

The formula for calculating the surface area of a sphere is $4\pi r^2$

The formula for calculating the area of a triangle is $\frac{h \times b}{2}$

(3)

Answer .....

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9 Changes in diet are affecting the health of people in the UK.

(a) The table shows mean data for adult males in the UK in 1967 and 50 years later in 2017.

Year	Mean mass / kg	Mean height / cm	Mean BMI
1967	73	172	24.7
2017	84	178	

The National Health Service (NHS) states that BMI can be used to assess the weight category of an adult male. The table shows these categories.

Category	BMI range
Underweight	$\leqslant$18.4
Healthy weight	18.5 – 24.9
Overweight	25.0 – 29.9
Obese	$\geqslant$30.0

The mean BMI for adult males in 1967 indicates that they were in the healthy weight category.

Use the BMI formula to determine the mean weight category for adult males in 2017.

$$\text{BMI} = \frac{\text{mass in kilograms}}{(\text{height in metres})^2}$$

(2)

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8 Biodiversity can be reduced by management of habitats.

(a) A study of plant species, other than grasses, found in two lawns was completed.

Lawn A was cut every 14 days. Lawn B was cut every 7 days.

The table shows the number of plants of each species identified.

Plant species	Number of plants	
	Lawn A	Lawn B
Daisy	18	5
Bee orchid	1	0
Dandelion	12	0
Clover	4	0
Bird's-foot trefoil	6	0

Biodiversity can be compared in different habitats using a formula to calculate an index of diversity (D).

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$

n = total number of organisms of a particular species

N = total number of organisms of all species

(i) Calculate the index of diversity for lawn A.

(3)

Answer .....

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(b) Brown Moss is a site of special scientific interest. It is an area containing shallow ponds, inhabited by birds and rare plants.

The biodiversity of plants growing in two ponds, A and B, at Brown Moss was studied. The table includes data collected from the two ponds.

Species	Number (n) in pond A	n(n–1) for pond A	Number (n) in pond B	n(n–1) for pond B
Azolla filiculoides	5	20	0	0
Lemna minuta	29	812	0	0
Lemna trisulca	50	2450	0	0
Alisma plantago-aquatica	2	2	0	0
Alopecurus aequalis	11	110	0	0
Carex pseudocyperus	2	2	0	0
Equisetum fluviatile	0	0	71	4970
Juncus effusus	0	0	60	3540
Menyanthes trifoliata	16	240	0	0
Polygonum amphibium	0	0	25	600
Ranunculus circinatus	13		0	0
Sparganium erectum	3	6	0	0
Typha latifolia	5	20	0	0
Total			156	9110

(i) Complete the table for pond A giving the value for n(n–1) for *Ranunculus circinatus* and give the totals.

(1)

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Question 10 · A level Paper 1 · June 2023 · Q2(b)(ii) · 2 marks

(ii) Calculate the index of diversity for pond B using the formula

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

(2)

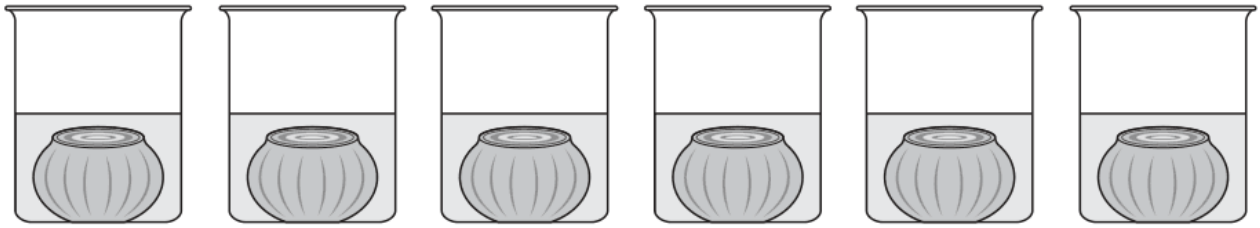
Answer .....

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5 Pickling is a technique used to preserve food. Onions can be pickled by immersing them in a solution of sodium chloride.

A student investigated the effects of changing the concentration of sodium chloride solution on the mass of onion tissue. Small onions were peeled, had their tops and bottoms cut off and were weighed. The onions were then placed into covered beakers containing different concentrations of sodium chloride solution.

Six beakers were set up as shown in the diagram.



0% sodium chloride solution | 2.5% sodium chloride solution | 5% sodium chloride solution | 10% sodium chloride solution | 15% sodium chloride solution | 20% sodium chloride solution

The beakers were left for two days. The onions were removed, blotted dry and reweighed. The investigation was repeated two more times.

The mean percentage change in mass was calculated.

The results of the investigation are shown in the table.

Sodium chloride solution (%)	Percentage change in mass (%)				SD
	1	2	3	Mean	
0.0	7.3	7.1	7.9	7.4	0.4
2.5	3.2	4.7	5.8	4.6	
5.0	–1.3	–0.9	–1.2	–1.1	0.2
10.0	0.6	–0.8	–1.9	–0.7	1.3
15.0	–2.1	–1.8	–2.9	–2.3	0.6
20.0	–2.2	–2.4	–1.9	–2.2	0.3

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Question 11 · AS Paper 1 · June 2019 · Q5(a)(ii) · 2 marks

(ii) Standard deviation can be calculated using the formula shown.

$$S = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

Calculate the standard deviation for the 2.5% sodium chloride solution.

(2)

Answer .....

Question 12 · A level Paper 3 · June 2023 · Q6(c)(ii) · 3 marks

(ii) The table contains the observed and expected results of this cross.

Phenotype	Observed number	Expected number
stripes and long fins	270	288
stripes and short fins	87	96
spots and long fins	115	96
spots and short fins	40	32
Total	512	512

Calculate a value for chi squared (χ^2).

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

(3)

Answer .....

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Question 13 · A level Paper 3 · November 2021 · Q5(a)(ii) · 3 marks

(ii) Some of the results of the investigation are shown in the table.

Forest	Number of bird species in areas of the forest where no trees are cut down	Number of bird species in areas of the forest where some trees are cut down
A	35	19
B	16	10

Calculate the Chi-squared value (χ^2) for forest B using the formula shown.

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

(3)

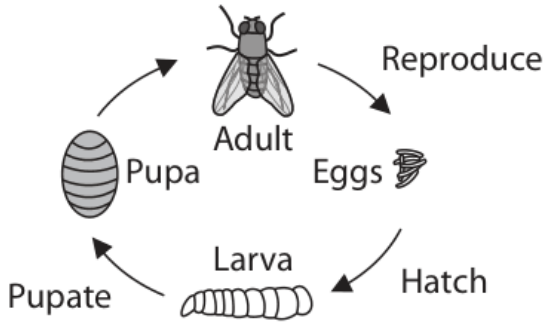
Answer .....

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Question 14 · information from earlier in the question

3 Blowflies are found in many parts of the world, including Africa.

The diagram shows the life cycle of one species of blowfly (species A) found in Africa.



An investigation was carried out to find the temperature at which 50% of the larvae of this species survive. This investigation was repeated for a further six species of African blowfly larvae, B to G. All other variables were kept constant.

In another investigation, the temperature of sand that the larvae selected when ready to pupate was recorded.

(a) A student used the data from these investigations to find out if there is a statistically significant correlation between the two sets of temperatures.

To do so, a Spearman's rank correlation coefficient can be calculated.

Question 14 · A level Paper 3 · June 2018 · Q3(a)(ii) · 3 marks

(ii) Calculate the Spearman's rank correlation coefficient (r_s) using the equation:

(3)

$$r_s = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

where $\Sigma d^2 = 34$ and n is the number of blowfly species.

Answer .....

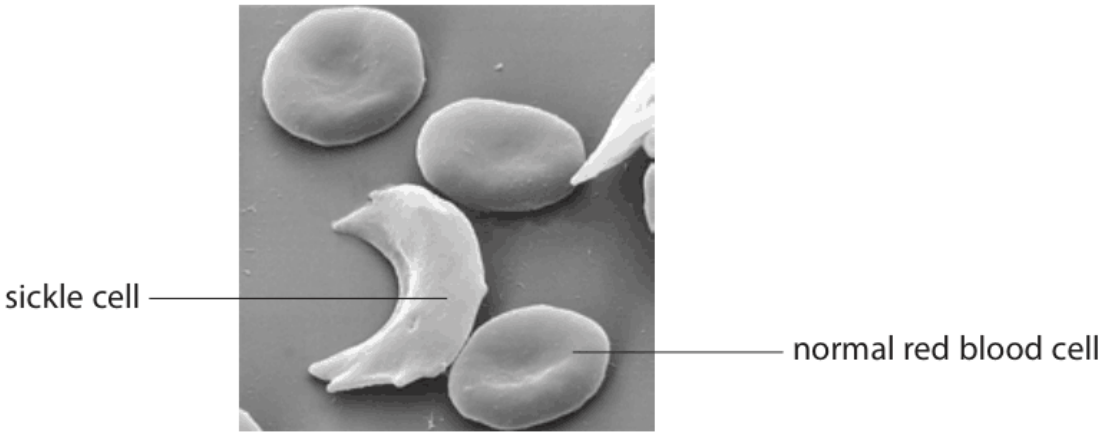
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Question 15 · information from earlier in the question

(b) Sickle cell anaemia is a genetic condition.

People who are homozygous for the sickle cell allele have red blood cells that become deformed in shape when they are deoxygenated.

The electron micrograph shows these deformed sickle cells alongside normal red blood cells.



Magnification ×3000

Question 15 · AS Paper 2 · June 2017 · Q4(b)(ii) · 3 marks

(ii) People with a heterozygous genotype for this condition do not develop severe sickle cell anaemia.

The Yoruba are a group of people who live in West Africa.

In a population of 600 Yoruba individuals, 24 were found to have severe sickle cell anaemia.

Calculate the number of heterozygous individuals in this population.

Use the Hardy Weinberg equation, $p^2 + 2pq + q^2 = 1$.

(3)

Answer .....

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Question 16 · AS Paper 2 · June 2024 · Q5(a)(i) · 3 marks

5 In 1832, the great bustard became extinct in the UK.

A reintroduction project released 20 of these birds into the wild.

(a) The Hardy–Weinberg equation can be used to calculate allele frequencies in populations.

This was used to determine the genetic diversity of this group of birds.

Two alleles were identified for one gene. The frequency of the dominant allele for this gene was found to be 0.8

(i) Use the Hardy–Weinberg equation to calculate the number of birds in this group that would have the dominant phenotype.

(3)

$$p^2 + 2pq + q^2 = 1$$

Answer .....

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3 During the civil war in Mozambique, from 1977 to 1992, 90% of the African elephants were killed for the ivory in their tusks.

Since 1992, the elephant population in Mozambique has increased.

The photograph shows a group of elephants in Mozambique.



© ALEXANDER JOE/Staff/Getty Images

A study of an elephant population in Mozambique was carried out in 2017.

The elephants studied were all born before 1992.

The table shows the number of elephants with and without tusks.

Elephants	Number of elephants
with tusks	98
without tusks	102

(a) The presence of tusks is controlled by a single gene. The allele for tusks is known to be dominant.

The frequency of alleles in a population can be determined using the Hardy-Weinberg equation.

Calculate the frequency of the dominant and recessive alleles in this population. Give your answer to 2 decimal places.

(3)

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Question 18 · A level Paper 3 · October 2020 · Q5(a)(ii) · 3 marks

(ii) The frequency of the G20210A allele in a population of 10 000 individuals was investigated.

In this population, 50 individuals were homozygous for G20210A.

Calculate the number of individuals in the population who were heterozygous for the G20210A allele, using the Hardy-Weinberg equation:

$$p^2 + 2pq + q^2 = 1.0$$

(3)

Answer .....

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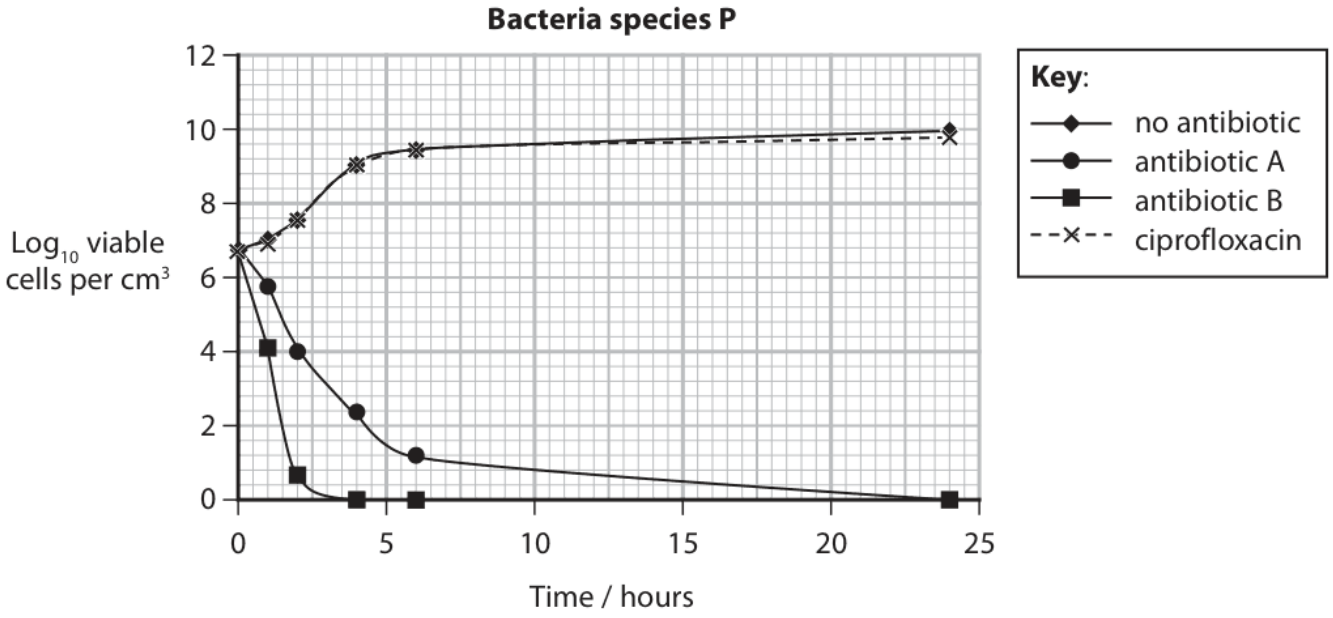
(b) Two new antibiotics have been developed: antibiotic A and antibiotic B. These were tested against two species of bacteria resistant to the antibiotic ciprofloxacin.

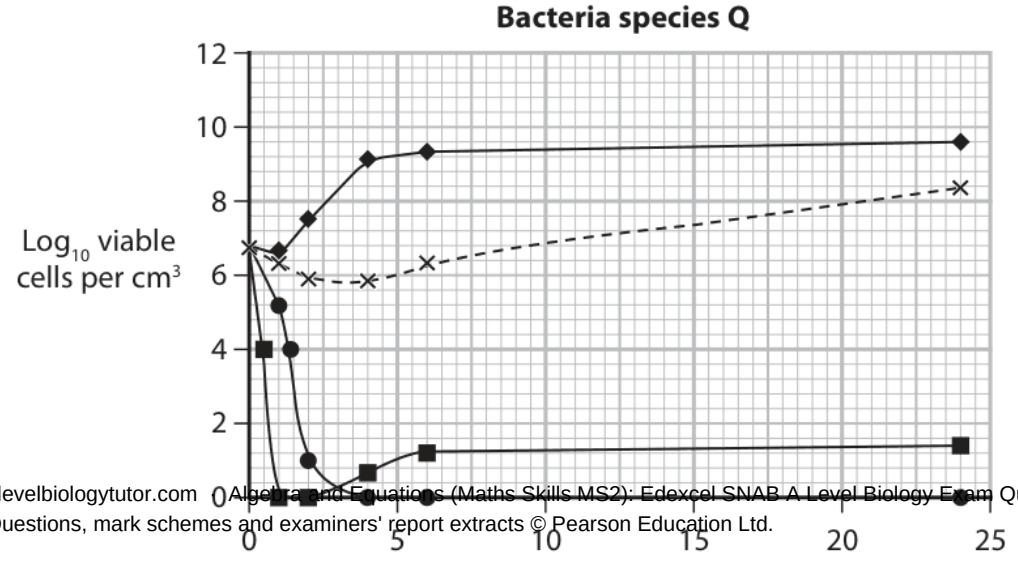
Each species of bacteria (P and Q) was grown in cultures containing:

- antibiotic A
- antibiotic B
- ciprofloxacin
- no antibiotic

Each culture was sampled at 0, 1, 2, 4, 6 and 24 hours and the number of viable cells was recorded.

The results of this investigation are shown in the graphs.





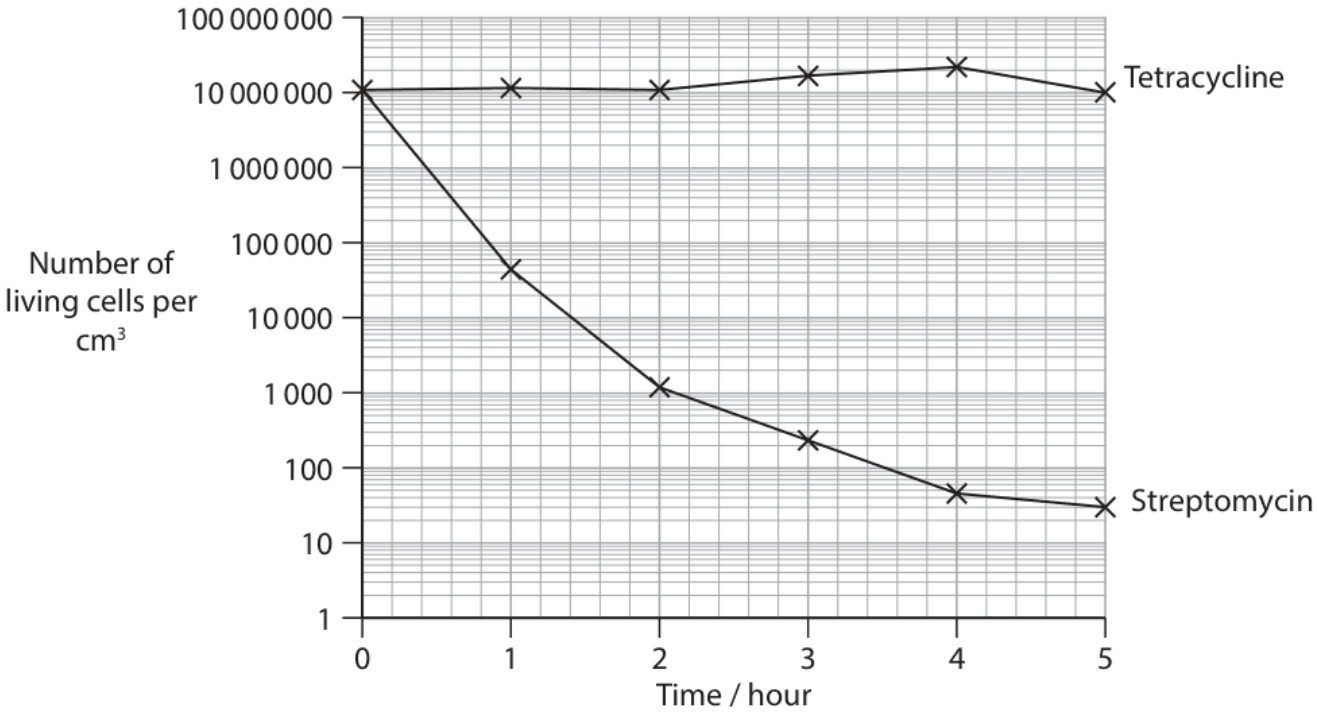
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(c) In a different investigation the effects of two antibiotics, tetracycline and streptomycin, were compared on cultures of *E. coli*.

Each antibiotic was added to a culture containing 10 000 000 living *E. coli* bacteria at time 0.

Samples were removed from the cultures every hour and the number of living bacteria was determined.

The results are shown in the graph.



(i) Calculate the ratio of living bacteria in the tetracycline culture compared with the streptomycin culture at five hours.

(2)

Answer ..... : 1

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Mark schemes

Question 1 · AS Paper 1 · June 2019 · Q4(c)(ii) · 2 marks

Question Number	Answer
4(c)(ii)	• values correctly substituted into rearranged equation (1) • correct answer with unit (1)

Additional Guidance	Mark
20×1.15^2 26.5 kg ALLOW 26.45 kg for one mark Correct answer with no working gains full marks	(2)

Question 2 · AS Paper 1 · June 2024 · Q7(a) · 2 marks

Question Number	Answer	Additional Guidance	Mark
7(a)	• (minimum height) {1.6 / 1.616 / 1.62} (1) • (maximum height) {1.8 / 1.80} (1)		(2)

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Question 3 · AS Paper 1 · June 2023 · Q8(c)(i) · 2 marks

Question Number	Answer
8(c)(i)	• values converted to same unit and substituted into equation (1) • correct calculation of volume with appropriate unit to one decimal place (1)

Additional Guidance	Mark
Example of calculation $\pi \times 0.5^2 \times 0.5$ OR $\pi \times 5^2 \times 5$ 0.4 cm^3 / 392.7 mm^3 Correct answer without working gains full marks	**(2)**

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Question 4 · A level Paper 3 · June 2025 · Q2(a)(i) · 2 marks

Question number	Answer
2(a)(i)	An answer that makes reference to the following: • correct values substituted into the equation (1) • correct answer to three decimal places (1)

Additional guidance	Mark
Example of calculation $V = \pi(0.2)^2 \frac{1}{3}$ = 0.042 (mm^3) One mark can be given for 0.0419 Correct answer with no working gains full marks.	(2)

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Question 5 · A level Paper 1 · June 2025 · Q9(b) · 3 marks

Question Number	Answer
9(b)	• correct calculation of the volume of the trunk (1) • multiply trunk volume by value for density (1) • correct value calculated and given to one decimal place (1)

Additional guidance	Mark
<u>Example of calculation</u> $3.0 \times (0.6)^2 \times \pi =$ 3.392920065876976697539654853941 9 (m^3) $3.393 \times 720 =$ 2,442.902447431423222228551494838 1 =1221.5 ALLOW 1220.4 for 2 marks ALLOW 4885.8 for 2 marks Correct answer with no working gains full marks	(3)

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Question 6 · A level Paper 3 · June 2022 · Q2(b) · 3 marks

Question number	Answer
2(b)	• surface area of virus (1) • surface area of one spike protein (1) • correct whole number (1)

Additional guidance	Mark
Example of calculation $4 \times \pi \times 120^2 = 180955.7\ (nm^2)$ ALLOW 180864 / 181028.6 $(22.4 \times 20) \div 2 = 224\ (nm^2)$ $180955.74 \div 224 = 808$ ALLOW 807 ECF for one incorrect area values For a maximum of 2 marks Correct answer with no working gains full marks.	(3)

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Question 7 · A level Paper 2 · June 2019 · Q9(a) · 2 marks

Question Number	Answer
9(a)	An answer that makes reference to the following: • BMI calculation for 2017 (1) • interpretation of data for BMI (1)

Additional Guidance	Mark
26.51 / 26.5 ALLOW if written in the table (just) in overweight category	(2)

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Question 8 · AS Paper 2 · November 2021 · Q8(a)(i) · 3 marks

Question Number	Answer
8(a)(i)	• N(N-1) is calculated (1) • sum of n(n-1) is calculated (1) • correct value for diversity index calculated (1)

Additional guidance	Mark
Example of calculation 41 x 40= 1640 480 3.4 / 3.42 Correct answer with no working gains full marks	**(3)**

Question 9 · A level Paper 1 · June 2023 · Q2(b)(i) · 1 mark

Question Number	Answer	Additional guidance	Mark
2(b)(i)	• 156 as n(n-1) for *Ranunculus circinatus* 136 as Total for Number (n) in Pond A 3818 as Total for n(n-1) for Pond A	All three figures correct for one mark	(1)

Question 10 · A level Paper 1 · June 2023 · Q2(b)(ii) · 2 marks

Question Number	Answer	Additional guidance	Mark
2(b)(ii)	• correct substitution into equation (1) • correct calculation of diversity (1)	Example of calculation (156 x 155) ÷ 9110 = 2.65 /2.654 / 2.7 Correct answer with no working gains full marks.	(2)

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Question 11 · AS Paper 1 · June 2019 · Q5(a)(ii) · 2 marks

Question Number	Answer
5(a)(ii)	• correct calculation of numerator (1) • correct calculation of standard deviation (1)

Additional Guidance	Mark
Example of calculation $\sum(x - \bar{x})^2 = 3.41$ $(3.2 - 4.6)^2 + (4.7 - 4.6)^2 + (5.8 - 4.6)^2$ $\sqrt{\frac{3.41}{2}} =$ 1.3 / 1.31 / 1.306 / 1.3057 Correct answer no working scores full marks ALLOW ECF if number other than 3.41 calculated	**(2)**

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Question 12 · A level Paper 3 · June 2023 · Q6(c)(ii) · 3 marks

Question number	Answer
6(c)(ii)	An answer that makes reference to the following: • correct O-E values (1) • correct $(O-E)^2 \div E$ values (1) • correct value for χ^2

Additional guidance	Mark
Example of calculation ALLLOW evidence of finding difference e.g. 270-288 =-18 ALLOW evidence of finding $(O-E)^2 \div E$ values e.g. $(270-288)^2 \div 288$ for 2 marks 7.73 ALLOW any correctly rounded value between 7.7 and 7.729167 Correct answer with no working gains full marks	(3)

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Question 13 · A level Paper 3 · November 2021 · Q5(a)(ii) · 3 marks

Question number	Answer
5(a)(ii)	• correct expected value (1) • correct values for observed minus expected squared (1) • correct answer (1)

Additional guidance	Mark
26 ÷ 2 = 13 $(16 - 13)^2 = 9$ and $(10 - 13)^2 = 9$ 1.38 ECF for incorrect expected value ALLOW one mark for 2.25 / 3.6	Choose an item (3)

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Question 14 · A level Paper 3 · June 2018 · Q3(a)(ii) · 3 marks

Question Number	Answer
3(a)(ii)	• numerator (top line of formula) correctly calculated (1) • denominator (bottom line of formula) correctly calculated (1) • correct answer (1)

Additional Guidance	Mark
Example of calculation 6 x 34 or 204 7 x 48 or 336 0.3929 / 0.393 / 0.39 Correct answer with no working scores full marks	(3)

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Question 15 · AS Paper 2 · June 2017 · Q4(b)(ii) · 3 marks

Question Number	Answer
4 (b)(ii)	• correct value for p and q • correct proportion of heterozygotes (2pq) • correct number of heterozygotes

Additional Guidance	Mark
Example of calculation ALLOW 0.2 and 0.8 either way round $2pq = 2 \times (0.8 \times 0.2) = 0.32$ number of heterozygotes = 2pq x 600 = 192 Correct answer with no working scores full marks	(3)

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Question 16 · AS Paper 2 · June 2024 · Q5(a)(i) · 3 marks

Question number	Answer
5(a)(i)	• correct value for p^2 (1) • correct value for 2pq (1) • correct number of individuals (whole number) (1)

Additional guidance	Mark
<u>Example of calculation</u> 0.64 0.32 (ALLOW 2 marks for 0.96 if answer is incorrect for using correct values to determine $p^2 + 2pq$) 19 Correct answer with no working gains full marks	(3)

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Question 17 · A level Paper 1 · November 2021 · Q3(a) · 3 marks

Question Number	Answer
3(a)	An answer that makes reference to the following • Hardy-Weinberg equation stated (1) • correct calculation of frequency of homozygous recessive individuals (1) • correct calculation of frequency of dominant and recessive alleles (1)

Additional guidance	Mark
Example of calculation $p^2 + 2pq + q^2 = 1.0$ $q^2 = 102 \div 200 = 0.51$ Dominant allele = 0.29 Recessive allele= 0.71 **Correct answer with no working gains full marks**	**(3)**

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Question 18 · A level Paper 3 · October 2020 · Q5(a)(ii) · 3 marks

Question number	Answer
5(a)(ii)	Choose an item. • correct proportion of homozygous individuals calculated (1) • correct probabilities (p and q) determined for Hardy-Weinberg equation (1) • correct number of heterozygotes determined (1)

Additional guidance	Mark
Example of calculation P^2 or q^2 = 0.005 p =0.0707 q = 0.9293 or 2pq = 0.1314 = 10 000 x 0.1314 = 1314 ALLOW p = 0.071 and q = 0.929 or 2pq = 0.1319 = 10 000 x 0.1319 = 1319 ALLOW three marks for 1302 ALLOW two marks for 1300 Correct answer with no working gains full marks	**(3)**

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Question 19 · A level Paper 1 · June 2024 · Q10(b)(i) · 2 marks

Question Number	Answer
10(b) (i)	• correct conversion from log number to actual number of cells at start (1) • decrease in number of cells divided by four and rate given (1)

Additional guidance	Mark
Example of calculation Antilog of 6.8 $\log_{10}$ = 6.3 million cells / 6 309 573 cells 6.3 million ÷ 4 = 1.575 million OR 6 309 573 ÷ 4 = 1.577 million ALLOW 1 mark for 6.8 ÷ 4 = 1.7 IGNORE - sign Correct answer with no working gains full marks	(2)

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Question 20 · A level Paper 3 · June 2025 · Q5(c)(i) · 2 marks

Question number	Answer
5(c)(i)	An answer that makes reference to the following: • both values correctly read from graph (1) • correct ratio (1)

Additional guidance	Mark
10 000 000 and 30 330 000 : 1 ALLOW 300 000 : 1 333 000 : 1 333 300 : 1 333 330 : 1 333 333 : 1 Correct answer with no working gains full marks	(2)

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