

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 6: MICROBIOLOGY AND PATHOGENS
CORE PRACTICALS

SCORE

/39

PERCENTAGE

%

STEMUP

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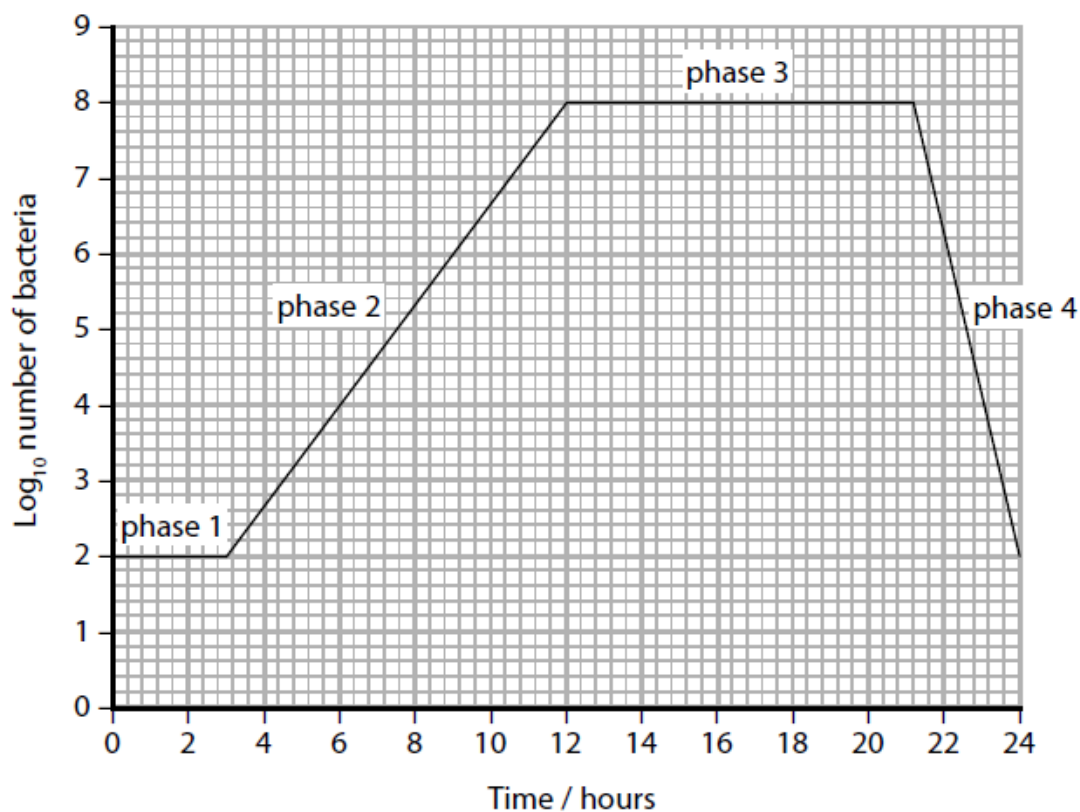
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Q1.

A broth culture for growing bacteria was set up.

Dilution plating was used to determine the number of live bacteria in the culture over a period of 24 hours.

The graph below shows the number of live bacteria in the culture during this 24-hour period.



(a) Which is the correct order of the phases 1 to 4 shown on the graph?

(1)

- ☒ **A** lag, log, death, stationary
- ☒ **B** lag, log, stationary, death
- ☒ **C** log, lag, death, stationary
- ☒ **D** log, lag, stationary, death

*(b) Evaluate the use of dilution plating and optical methods for determining the number of bacterial cells in a culture.

(6)

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(c) Calculate the growth rate constant (k) for phase 2 of this culture, using the formula:

$$k = \frac{\log_{10} N_t - \log_{10} N_0}{0.301 \times t}$$

(4)

Answer

(Total for question = 11 marks)

Q2.

Salmonella are Gram negative bacteria found in the large intestine of humans.

A scientist studied the growth of *Salmonella*.

(i) *Salmonella* was isolated from a mixed culture of bacteria, using streak plating onto selective media.

Explain why this is a suitable method for isolating the *Salmonella*.

(4)

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(ii) The scientist made a broth culture of *Salmonella* at a concentration of 5×10^3 cells per cm^3 .
Ten hours later the concentration of *Salmonella* was 4×10^6 per cm^3 .

Calculate the exponential growth rate constant (k) for this culture of *Salmonella* using the formula

(3)

$$k = \frac{\log_{10} N_t - \log_{10} N_0}{0.301 \times t}$$

Answer

(iii) In this calculation, the scientist did not allow for the time that the *Salmonella* spent in the lag phase.
Explain the effect that this will have on the calculated value for the growth rate constant.

(3)

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(Total for question = 10 marks)

Q3.

Aseptic conditions are used when growing bacteria in laboratories.

Justify two methods, other than UV radiation, for ensuring aseptic conditions.

(2)

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(Total for question = 2 marks)

Q4.

Streak plating is used in microbiology to separate individual species of bacteria from a mixed liquid culture.

(a) Describe how streak plating can be used to isolate individual bacterial colonies from a mixed liquid culture.

You may use a diagram in your answer.

(5)

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(b) Explain why agar plates should be incubated below 30°C in a school laboratory.

(2)

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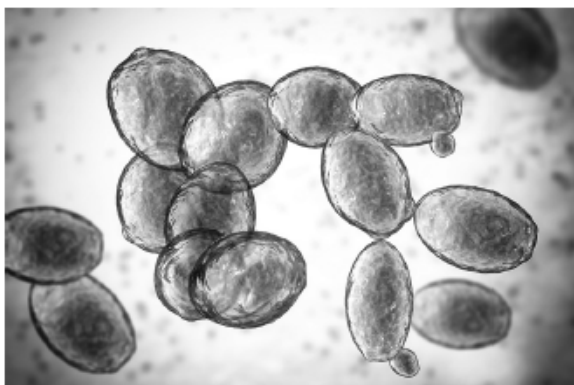
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(Total for question = 7 marks)

Q5.

Yeast, *Saccharomyces cerevisiae*, is a single-celled organism used in brewing and baking.

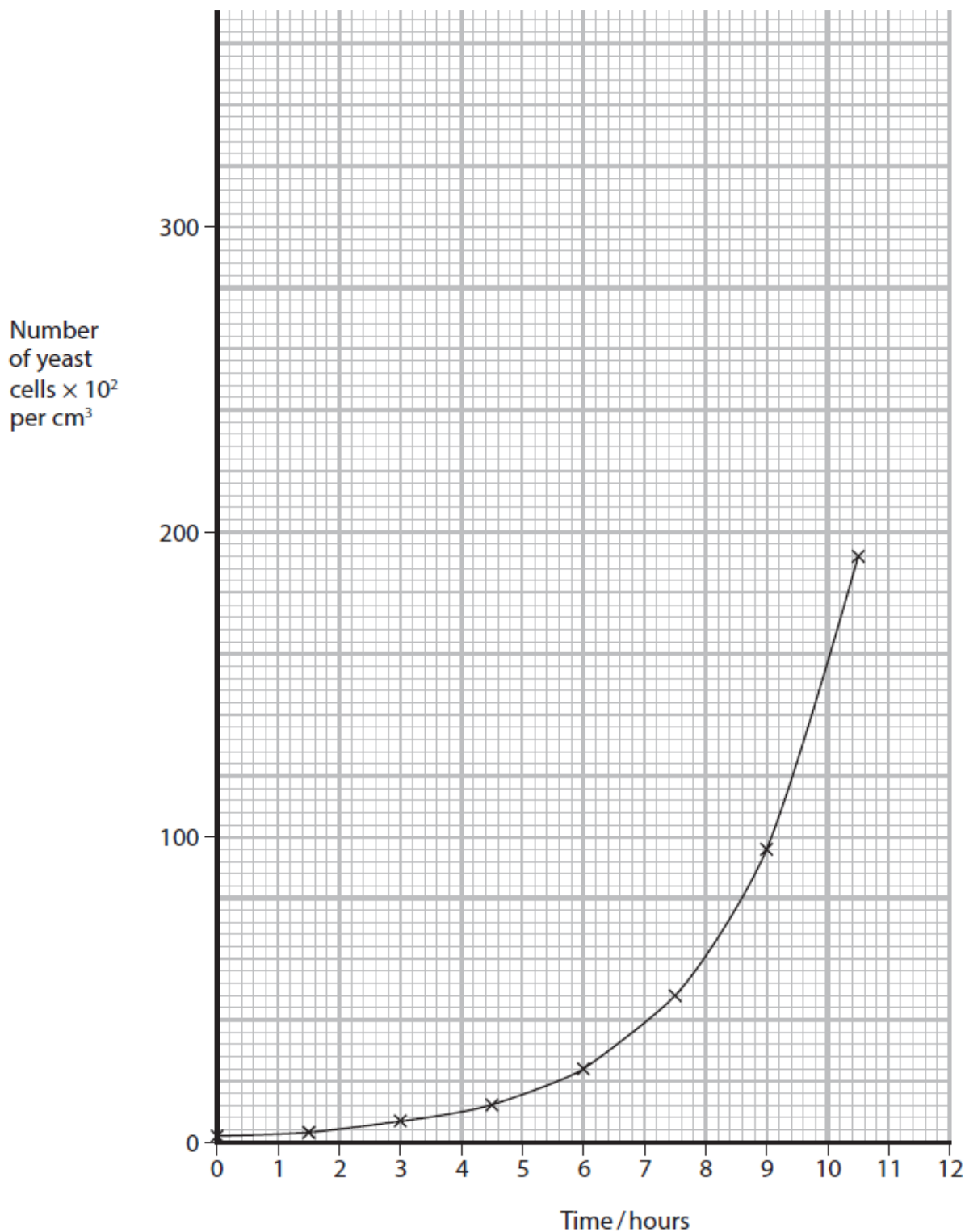
The photograph shows yeast cells seen using a light microscope.



(Source: © Kateryna Kon/Shutterstock)

A student counted the number of yeast cells, at 90-minute intervals, growing in a liquid culture at 30°C.

The graph shows the results.



(i) Calculate the percentage increase in the number of yeast cells from 2 hours to 6 hours.

(2)

Answer %

(ii) Predict the number of cells per cm^3 of the culture at 12 hours.

Assume that the culture continues to grow at the same rate.

(1)

Answer $\times 10^2$ per cm^3

(Total for question = 3 marks)

Q6.

Yeast, *Saccharomyces cerevisiae*, is a single-celled organism used in brewing and baking.

The photograph shows yeast cells seen using a light microscope.



(Source: © Kateryna Kon/Shutterstock)

A student counted the number of yeast cells, at 90-minute intervals, growing in a liquid culture at 30°C.

The student counted the yeast cells using a haemocytometer.

The table shows the number of cells counted using a haemocytometer.

Time / hours	Number of cells						
	1	2	3	4	5	Mean	Standard deviation (SD)
0.0	1	2	2	1	2	1.6	0.5
1.5	2	3	3	3	2	2.6	0.5
3.0	4	9	9	3	7	6.4	
4.5	13	10	12	9	16	12.0	2.7
6.0	43	31	18	14	15	24.2	12.5

(i) The student calculated the standard deviations using the following formula.

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

Calculate the standard deviation for the sample at 3 hours. (3)

(ii) The student concluded that the yeast population doubles every 90 minutes. Comment on the validity of this conclusion. (3)

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(Total for question = 6 marks)

Mark Scheme

Q1.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	B		(1)

Question Number	Indicative content
*(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • Dilution plating takes longer to obtain a result but optical methods are quicker • Because incubation period needed for dilution plating • Because need to do serial dilutions to find correct concentration for dilution plating • Dilution plating counts living cells but optical methods measure living and dead cells • Dilution plating gives direct count but optical methods give turbidity reading • To calculate original concentration of bacterial cells, the volume of diluted suspension added to each agar plate needs to be known / optical methods require use of calibration curves • Dilution plating requires easily available apparatus but optical methods require colorimeter / spectrophotometer • Dilution plating has risk of error if colonies run into each other but optical methods produce error if tube not shaken

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.
Level 3	5-6	A scientific judgement is made that is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.

Question Number	Acceptable Answer	Additional Guidance	Mark
(c)	$\log_{10} N_t = 8$ and $\log_{10} N_0 = 2$ (1) $\log_{10} N_t - \log_{10} N_0 = 6$ (1) $t = 9$ (1) $k = 2.215$ (1) [ecf applies for mps 2, 3 and 4]	Correct answer gains full marks with no working	(4)

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to four of the following: - medium allows only {<i>Salmonella</i> / certain bacteria} to grow (1) {culture / colonies / bacteria} is spread out on the {agar / medium} (1) - because this separates out individual bacteria (1) - so that colonies are {discrete / separate / individual} (1) - so only one type of {bacteria / colony} can be picked up (1)	ACCEPT in context of {named media / antibiotic-containing media}	(4)

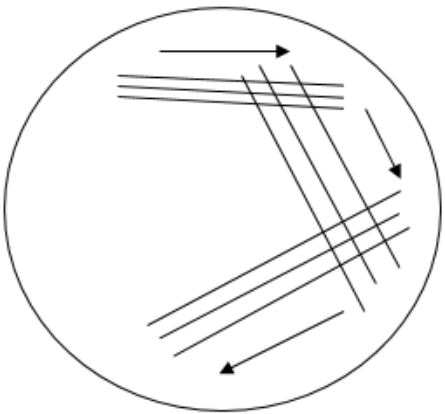
Question Number	Answer	Additional Guidance	Mark
(ii)	- log of the values taken (1) - substitution of values into equation (and evaluating correctly) (1) - k given to an appropriate number of decimal places (1)	$\log 5 \times 10^3 = 3.6989700043$ and $\log 4 \times 10^6 = 6.6020599913$ $(6.6020599913 - 3.6989700043) \div (0.301 \times 10) = 0.9644817233$ ACCEPT correct value for rounded up values substituted 0.964 / 0.96 CE applies from mp 1 only	(3)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: - the value for t used in the calculated value is greater than the actual value (1) - therefore the calculated value for k will be smaller (1) - because the <i>Salmonella</i> will not be replicating (in lag phase) (1)	ACCEPT converse for actual value ACCEPT converse for actual value ACCEPT dividing / growing	(3)

Q3.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to two of the following: {flame / sterilise / autoclave} apparatus to kill bacteria (1) - clean surfaces with {bleach / disinfectant / alcohol} to kill bacteria (1) - open lid of Petri dish slightly to prevent access by bacteria (1) - work near Bunsen flame to {create updraft / prevent bacteria settling} (1)	Accept microbes / spores for all points	(2)

Q4.

Question Number	Correct Answer	Additional guidance	Mark
(a)	 A description that makes reference to the following: • <u>flame</u> a wire loop / use of <u>sterile</u> swab (cotton bud) (1) • first streaks of sample in straight /zig-zag lines on surface of <u>sterile</u> agar plate (1) • at least 3 streaks in total (1) • second and third streak must pass through lines of previous streak (1) • incubate and take off individual colonies with wire loop (1)	Accept points from an appropriately labelled diagram (must be labelled if not described in text)	(5)

Question Number	Correct Answer	Additional guidance	Mark
(b)	An explanation that makes reference to the following: • above 30 °C close to human body temperature (1) • so risk of incubating human pathogens which could infect students (1)	Reject higher temperature might kill off some bacteria	(2)

Q5.

Question Number	Answer	Additional Guidance	Mark
(i)	• calculation of difference (1) • calculation of % increase (1)	Example of calculation $2400 - 400 = 2000 \qquad 24 - 4 = 20$ $\frac{2000}{400} \times 100 = 500 (\%) \qquad \frac{20}{4} \times 100 = 500$ Correct answer with no working gets 2 marks	Grad (2)

Question Number	Answer	Additional Guidance	Mark
(ii)	correct answer (1)	384 ($\times 10^2$ per cm^3) Accept 360 to 400 ($\times 10^2$ per cm^3)	Grad (1)

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	- calculation of $\Sigma (x - \bar{x})^2$ (1) - divided by $\{4 / n-1\}$ (1) - calculation of SD (1)	Example of calculation 31.2 7.8 2.8 2.498 / 2.5 gets mp1 if some working shown (31.2 divided by 5) Correct answer with no working gains 3 marks	Exp (3)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer including the following: - SD for times 0, 1.5, 3 and 4.5 hours are non-overlapping, so this conclusion is likely to be valid (1) - SD for 6 hours overlaps with SD for 4.5 hours, so this conclusion is not likely to be valid (1) - description of possible error (1) - value of 43 may be an anomalous result (so this conclusion may not be valid) (1)	Accept SD for 6 hours overlaps with SD for 4.5 hours with comment on difference / significance Accept eg dilution error, measurement error, counting error	Exp (3)

