GCE Biology

S21-A400U10-1

Assessment Resource 2

Energy for Life Resource B

Examiner only

1. The Archaea are a domain of single-celled microorganisms. These microbes are prokaryotes. Most Archaea possess a cell wall which is assembled from surface-layer proteins. These form an S-layer which is a rigid array of protein molecules that cover the outside of the cell. This layer provides both chemical and physical protection. Unlike bacteria, most Archaea lack peptidoglycan in their cell walls.

(a) (i) Describe **two** major features of a eukaryote which would allow you to distinguish it from a prokaryote. [1]

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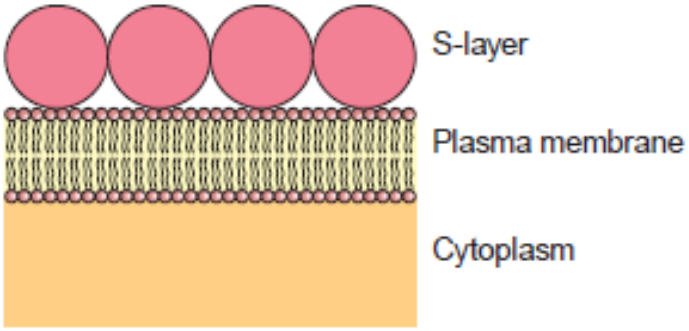
One type of cell wall found in Archaea is shown below.



(ii) Apart from the lack of peptidoglycan, describe how the cell walls of Gram negative bacteria would differ from those of Archaea. [2]

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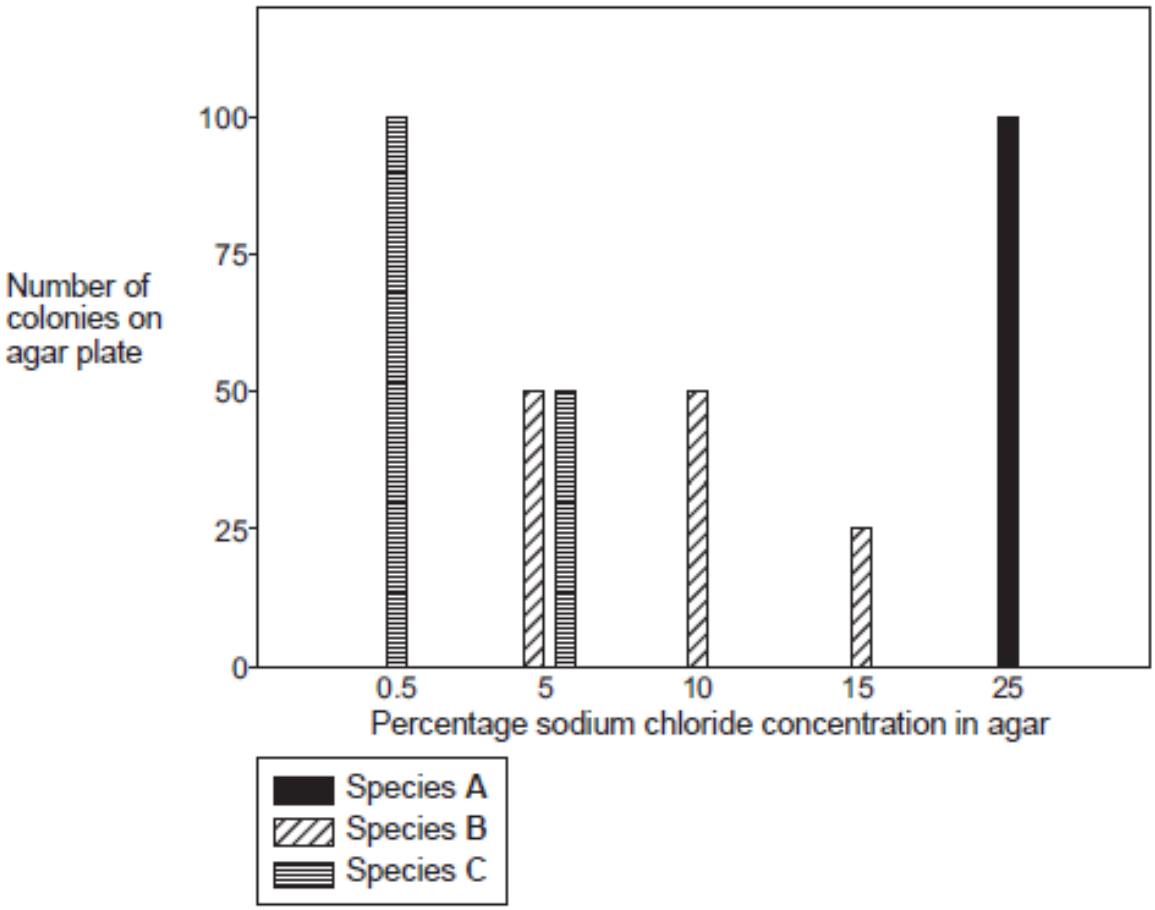
(b) An experiment was carried out to determine the effect of sodium chloride concentration (salinity) on the growth of different species of prokaryotes. The number of visible colonies of each species was counted on agar plates containing different concentrations of sodium chloride.
A bar chart of the results is shown below.



- *Staphylococcus aureus* is a Gram-positive bacterium that is frequently found on sweaty skin.
- *Halobacterium salinarum* is a marine Gram-negative obligate aerobic archaeon. Despite its name, this microorganism is not a bacterium, but rather a member of the domain Archaea.
- *Escherichia coli* is a Gram-negative, rod-shaped bacterium commonly found in the lower intestine of endothermic (warm-blooded) organisms.

(i) Which agar plate used in this experiment has the lowest water potential? [1]

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(ii) Identify species **A**-C giving reasons for your conclusions. [3]

A .....

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B .....

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C .....

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(iii) *Enterococcus faecalis* is a Gram-positive bacterium which also inhabits the gastro-intestinal tracts of humans and other mammals.
Briefly describe **two** ways in which you could distinguish between *Enterococcus faecalis* and *Escherichia coli*. [3]

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(c) Some strains of *E. coli* can cause food poisoning. Following an outbreak, samples were taken from suspected food sources and cultured on agar plates. Serial dilutions were carried out to determine the number of viable bacteria in the samples. 0.25 cm^3 was transferred to each agar plate and incubated at 37 °C. The number of colonies on each plate was then counted.

	Number of colonies per plate				
Dilution	Plate 1	Plate 2	Plate 3	Mean	SD
10^{-3}	426	503	521	483	50.5
10^{-5}	444	479	457	460	17.7
10^{-7}	275	293	310	293	
10^{-9}	66	71	78	72	6.0

(i) Calculate the missing standard deviation (SD) using the following formula. [3]

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

s = standard deviation

Σ = sum of

x = each value in the data set

$\bar{x}$ = mean of all values in the data set

n = number of values in the data set

The following table is given to help structure your calculation.

Plate number	Number of colonies per plate	$x - \bar{x}$	$(x - \bar{x})^2$
1	275		
2	293		
3	310		
Mean	293		Σ

Standard deviation = ...

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(ii) Suggest why the **mean values** for the first two dilutions were so close despite there being a 100 times difference in the dilutions. [1]

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(iii) State what the standard deviations of the **first two dilutions** tell you about the data. [1]

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(iv) Calculate the number of bacteria in **1 cm^3** of the original sample using the 10^{-9} dilution. **Give your answer in standard form.** [3]

Number of bacteria = ...

18

2. Hydrogen carbonate indicator can be used to assess the carbon dioxide concentration in solution.
The colours displayed by hydrogen carbonate indicator at different concentrations of CO_2 are shown below.

yellow		orange		red		magenta		purple
pH 7.6	pH 7.8	pH 8.0	pH 8.2	pH 8.4	pH 8.6	pH 8.8	pH 9.0	pH 9.2

An experiment was carried out to find the light intensity where the rate of respiration and photosynthesis are exactly equal (the compensation point) in a species of alga immobilised in algal balls.

- Six glass bottles were set up each containing 50 algal balls and 25 cm^3 hydrogen carbonate indicator at the same CO_2 concentration. A range of five light intensities at the same wavelength were used.
- One was covered in aluminium foil to exclude all light.
- All of the bottles were left for one hour.
- The absorbance of the six solutions was measured in a colorimeter.
- The colorimeter measured the light absorbed by the sample as less than or greater than the initial colour of the tube.

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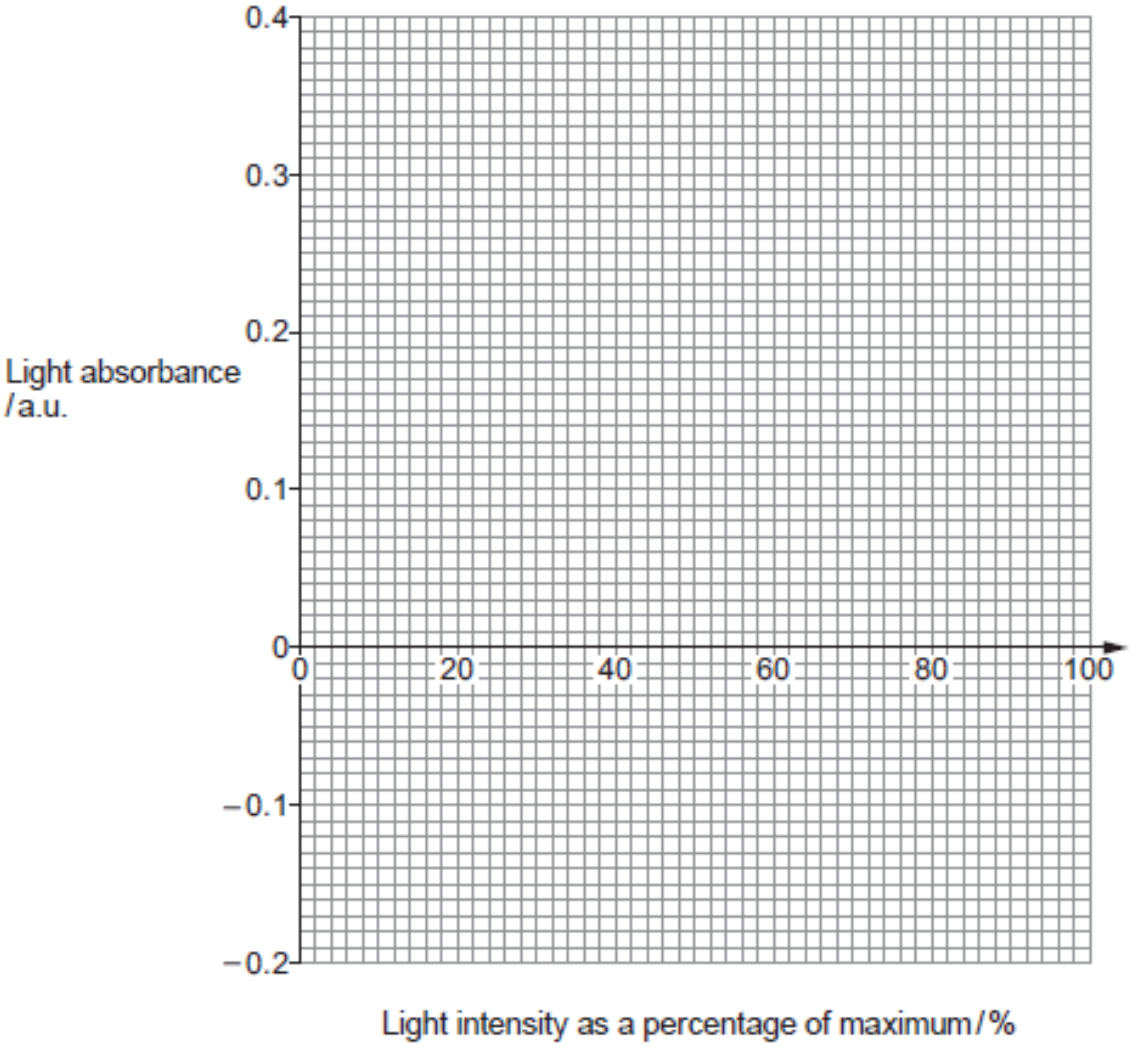
The results are shown in the table.

Light intensity as a percentage of maximum / %	Light absorbance of the sample / a.u.
0.0	–0.15
12.5	–0.10
25.0	–0.03
50.0	0.17
75.0	0.30
100.0	0.34

(a) (i) Plot the data on the grid below. [2]



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(ii) **Use the graph** to determine the compensation point. [1]

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(iii) With reference to the biochemical pathways of photosynthesis and respiration, explain how a light absorbance of 0 a.u. could be observed in this experiment. [4]

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(b) Explain why the colorimeter was used rather than visually assessing the change in colour of the indicator. [1]

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(c) State **two** *other* variables that should have been controlled in this experiment. [2]

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(d) A shade plant such as primrose must be able to photosynthesise effectively at lower light intensities, whilst grass species such as maize grow on open land.
How would you predict the compensation points of maize and primrose to differ?
Explain your answer. [2]

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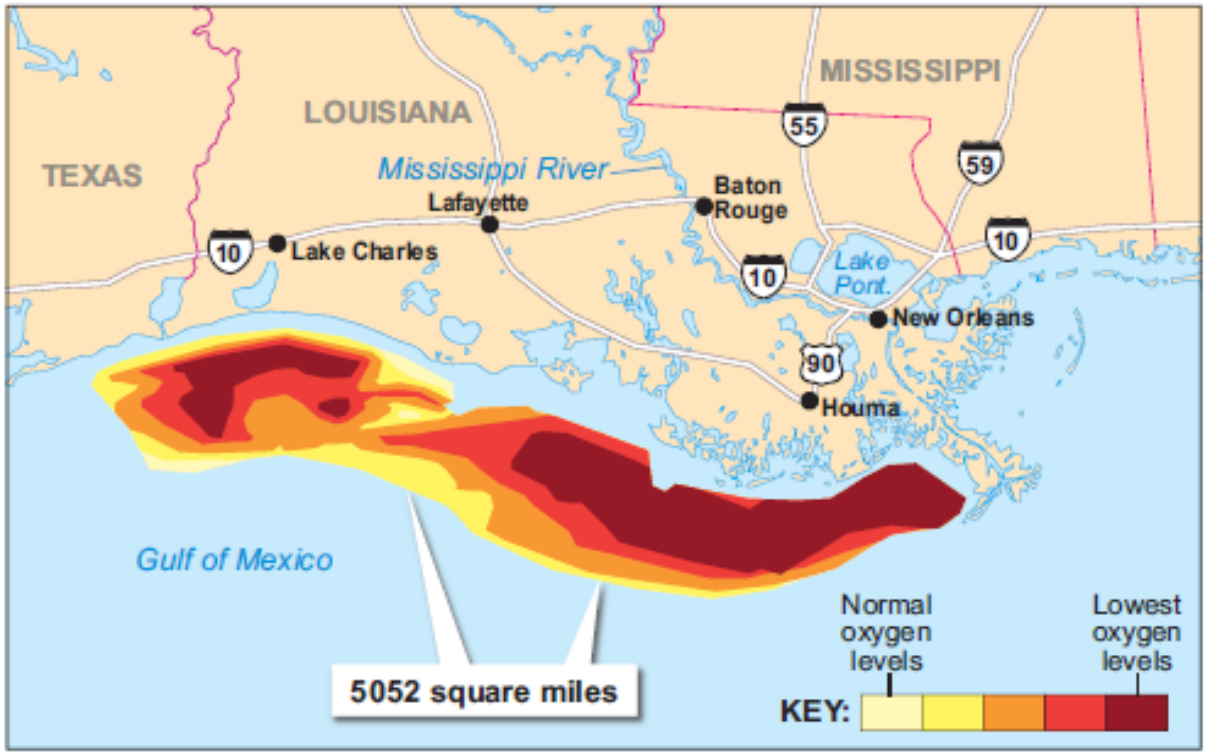
(e) The coloured area on the map below shows an area of 5052 square miles, sampled in 2014, in the Gulf of Mexico which has extremely low oxygen levels at certain times of the year. The Mississippi River drains a large area of agricultural land, growing crops such as maize and soybean. It drains into the Gulf of Mexico.

2014 DEAD ZONE Area of oxygen-deprived water



Using your knowledge of algal growth explain how the area of oxygen-deprived water in the Gulf of Mexico has occurred. [5]

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