

Genetic information, variation and relationships between organisms – A2 Biology

1. No.6

0 6 . 1

Define genome and proteome.

[2 marks]

Genome All the genes in a cell.All the DNA in a cell.Proteome Full range of proteins that a cell can produce.

The classification system used in the early 20th century grouped different species of bacteria according to the position and shape of flagella on bacterial cells and by the number of flagella per cell. These were observed using an optical microscope. Each species of bacterium has a characteristic cell shape and arrangement of flagella. These characteristics may be shared with other species within a genus. Flagella are fragile, difficult to stain and may extend from the cell at any angle.

0 6 . 2

Consider the accuracy and limitations of the early classification of bacteria using the arrangement of flagella.

[3 marks]

✓ Flagella is difficult to stain and it may not be visible.

→ Not all bacteria have flagella. So the method of classification is not accurate.

- Resolution for optical microscope is low. So, fine details of flagella are not possible to be seen.

- Flagella are fragile and easily get broken. So they are difficult to handle.

06.3

Suggest why several bacterial species have been renamed in recent years.

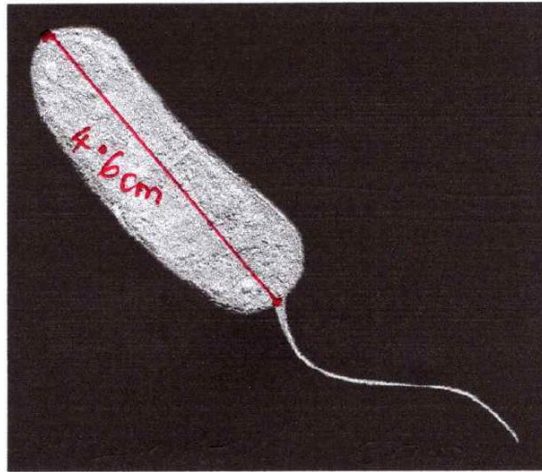
[1 mark]

Use of electron microscope with higher resolution has revealed more details about bacteria species.

06.4

Figure 6 shows an image from an optical microscope of a single bacterial cell.

Figure 6

This bacterial cell is $2.3 \mu\text{m}$ long (excluding the flagellum). $1000 \mu\text{m} = 1\text{mm}$

Calculate the magnification of this image.

 $1\text{cm} = 10\text{mm}$

Show your working.

 $4.6\text{mm} = 46\text{mm}$

$$\text{magnification} = \frac{\text{Image length}}{\text{actual length}} = \frac{46\text{mm}}{2.3 \times 10^{-3}\text{mm}} = \underline{\underline{\times 20,000}}$$

[2 marks]

Magnification $\times$ 20,000

2. No.8

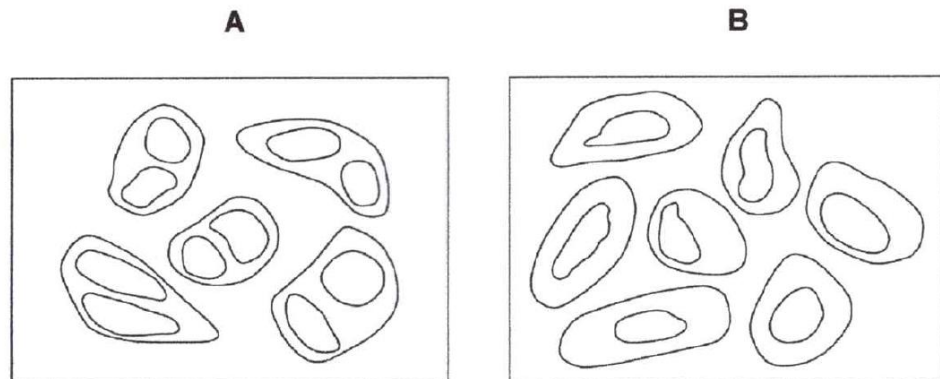
08.1

Scientists investigated a drug called MiTMAB as a treatment for cancer. MiTMAB inhibits cytokinesis.

Figure 8 shows drawings of cancer cells seen with an optical microscope from a:

- sample treated with MiTMAB
- control sample.

Figure 8



The cells in drawing **A** can be identified as those treated with MiTMAB.

Explain why.

[2 marks]

The cells stopped dividing at telophase.
The drug prevented cytokinesis. So, new cell
membrane never formed.

08.2

MiTMAB acts as a non-competitive inhibitor of an enzyme called dynamin.

Suggest how MiTMAB can cause dynamin to become inactive.

[3 marks]

MiTMAB binds to dynamin other than the active site. This causes a change in the shape of active site. So, the enzyme is not complimentary to substrate. So, fewer enzyme-substrate complexes form.

When active, dynamin has **two** functions:

- it stimulates cytokinesis
- it inhibits cell death.

The scientists treated actively growing cultures of cancer cells with MiTMAB.

They incubated:

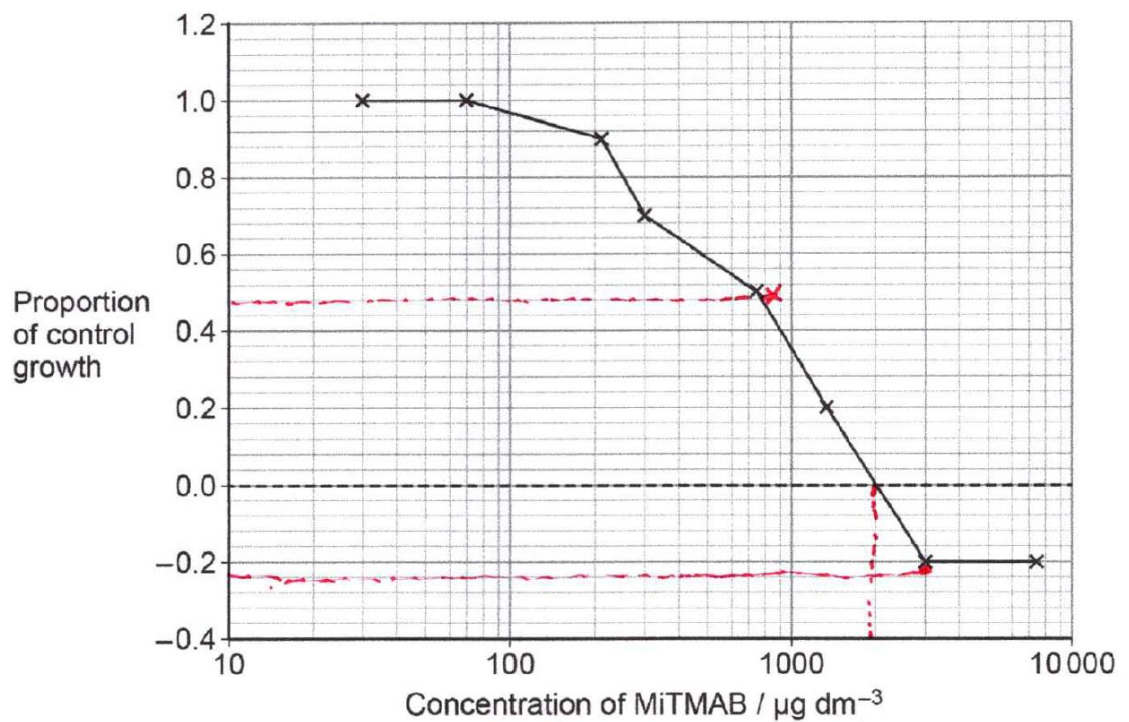
- one sample of 2500 cells without MiTMAB as a control
- eight samples, each with 2500 cells and a different concentration of MiTMAB.

After 72 hours, the scientists measured the number of cells in each sample.

Figure 9 shows the scientists' results.

A negative value for proportion of control growth means that fewer than 2500 cells were counted after 72 hours.

Figure 9



$$\frac{19}{0.01} = 1900$$

08.3

Use all the information given to explain the results shown in Figure 9.

[3 marks]

At lowest concentrations, MiTMAB does not cause cell death. Cell death increases as the concentration of MiTMAB increases. This is because as MiTMAB concentration increase, cytokinesis decrease. This causes cell death.

There is no change in cell number at $2000 \mu\text{g}/\text{dm}^3$. This indicates MiTMAB inhibits cell division.

08.4

0.01 dm^3 of MiTMAB solution was added to the treated cells.

Calculate the increase in mass of MiTMAB (in μg) added to the cells to reduce the cell growth from equal to the control to 0.0 of the control.

Show your working.

$$0.01 \text{ dm}^3 \xrightarrow{1000} \frac{19}{0.01} = 1900$$

[2 marks]

Answer 1900 μg

3. No.3

0 3 . 1

Below are **four** statements about the structure of prokaryotic cells.

- ✓1. No prokaryotic cell has DNA that is associated with proteins. *- true*
- ✓2. No prokaryotic cell has membrane-bound organelles. *- true*
3. All prokaryotic cells have one or more flagella. *- wrong*
- ✓4. All prokaryotic cells have smaller ribosomes than eukaryotic cells. *- true*

Which statements about the structure of prokaryotic cells are correct?

Tick (✓) **one** box.

[1 mark]

A statements 1, 2 and 3

☐*- 3 is false*

B statements 1, 2 and 4

☒*- true*

C statements 2, 3 and 4

☐*- 3 is false*

D statements 1, 2, 3 and 4

☐*- 3 false*

A student investigated the effect of **two** antibiotics on the growth of the bacterium *Micrococcus luteus*.

During the investigation, the student:

- transferred 9 cm^3 of a liquid culture of *M. luteus* into each of **three** bottles
- added the antibiotic chloramphenicol to the first bottle
- added the antibiotic novobiocin to the second bottle
- added no antibiotic to the third bottle.

After 24 hours, he diluted the contents of each bottle by 1 in 100 000 (10^{-5}). He then transferred 0.25 cm^3 samples from the first bottle onto each of 3 separate agar plates. He repeated this with 0.25 cm^3 samples from the second bottle and the third bottle, resulting in 9 agar plates in total.

He incubated the plates for 48 hours.

Table 1 shows the number of colonies of bacteria he counted on each plate after 48 hours' incubation.

9 x 0.144)

Table 1

Plate	Number of colonies of bacteria		
	with chloramphenicol	with novobiocin	with no antibiotic
1	2	238	276
2	4	263	258
3	6	261	324

0 3 . 2

Calculate the mean number of bacteria in the undiluted bottle of liquid culture containing novobiocin.

Give your answer in standard form. Show your working.

content of each bottle = 1 in 100,000 dilution [2 marks]
 Mean colony count = $\left[\frac{238 + 263 + 261}{3} \right] \times 100,000 = 254,000$
 in 0.25cm^3 and 9 bottles
 Total bacteria in undiluted Bottle = $\frac{254 \times 100,000 \times 9}{0.25}$
 $= 9.144 \times 10^8$

Answer 9.144×10^8 bacteria

0 3 . 3

Starting with a single bacterium, calculate how many generations it would take to produce at least the number of bacteria you have calculated for your answer in Question 03.2

You can assume no bacteria die.

You could use the ln or log button on your calculator to calculate your answer.

$2^x = 9.14 \times 10^8$ [1 mark]
 $\ln 2^x = \ln 9.14 \times 10^8$
 $x = \frac{\ln(9.14 \times 10^8)}{\ln 2} = 30$

Answer 30 generations

03.4

M. luteus is not resistant to chloramphenicol.

Suggest **two** reasons why the bacteria were able to grow in the culture containing chloramphenicol.

[2 marks]

- 1 The concentration of chloramphenicol was too low to kill all the *M. luteus*.
Mutations took place.
- 2 There were too many bacteria for the antibiotic to kill.