Q1.

(a) Describe how viruses are replicated.

(4)

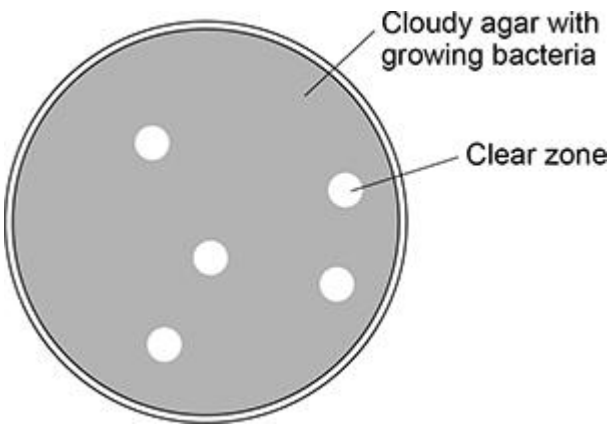
(b) A scientist investigated the effect of a virus species on a bacterial culture.

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 1 shows the appearance of the Petri dish after 24 hours.

Figure 1



Explain why clear zones are present in **Figure 1**.

_____

_____

_____

(1)

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

_____

_____

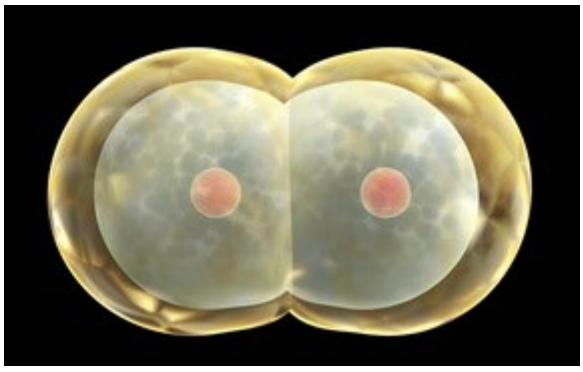
_____

(1)

(d) Animal cells replicate during the cell cycle.

Figure 2 shows one animal cell at a stage of the cell cycle.

Figure 2



Identify the stage of the cell cycle shown in **Figure 2**.

Explain the appearance of the cell shown in **Figure 2**.

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

Identity of stage _____

Explanation _____

_____

_____

(2)

(Total 8 marks)

Q2.

(a) Describe the appearance **and** behaviour of chromosomes during prophase and during anaphase of mitosis.

Prophase _____

_____

_____

_____

Anaphase _____

_____

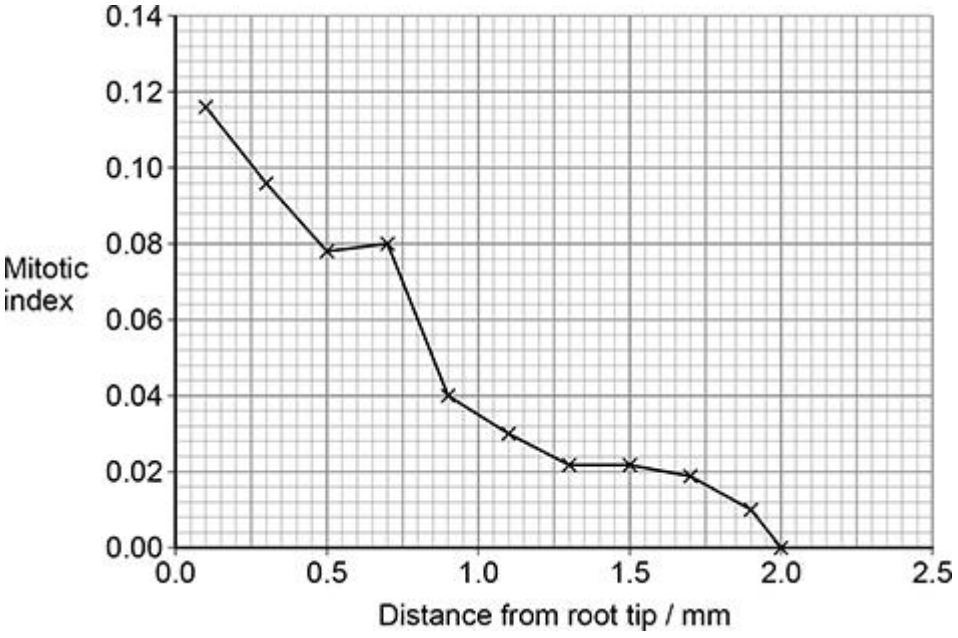
_____

_____

(4)

(b) A scientist used an optical microscope to determine the mitotic index in cells at different distances from the tip of onion roots.

The graph below shows the results.



Complete the word equation used to determine each mitotic index in the graph above.

Mitotic Index =

(1)

(c) The scientist used data from the graph above to calculate a correlation coefficient (r). The scientist then used a statistical test to determine the probability (P) associated with the value of r.

$r = -0.98$ ($P < 0.05$)

What can you conclude from this result?

(2)

(d) What can you conclude about the effect that distance from the root tip has on the proportion of cells in different stages of the cell cycle?

Use information in the graph above.

(3)

(Total 10 marks)

Q3.

(a) A student prepared a plant root to observe cells undergoing mitosis.

He put the root in a small bottle of hydrochloric acid in a 40 °C water bath.

Why did he put the plant root in acid?

_____

_____

_____

(1)

(b) State **two** precautions required when working with hydrochloric acid.

1 _____

_____

_____

2 _____

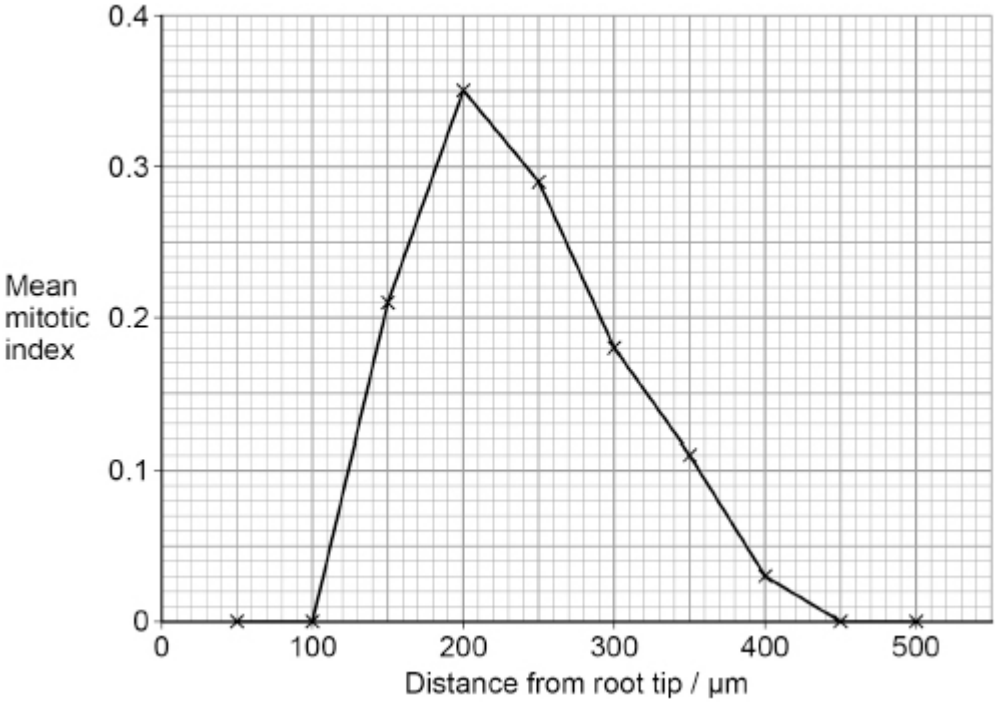
_____

_____

(2)

(c) Scientists determined the mean mitotic index at 50 μm intervals away from the root tip in 10 young plant roots.

The graph below shows the scientists' results.



State the null hypothesis for this investigation.

Name the statistical test needed to determine whether the difference between the mean mitotic index at 200 μm and at 300 μm is significant.

Null hypothesis _____

_____

_____

Statistical test _____

(2)

(d) The scientists recorded these measurements from the tissue located at 200 µm from the root tip.

Area of field of view = 0.2 mm^2
Mean area of one cell = 3495 $µm^2$

Use this information and the graph in (c) to calculate the number of cells undergoing mitosis in this location.

Assume there are no spaces between the cells.

Show your working.

_____ cells

(2)

(e) Another student compares the mitotic index in the roots of two different species.

Give **two** considerations within her method to ensure this comparison is valid.

1 _____

_____

_____

2 _____

_____

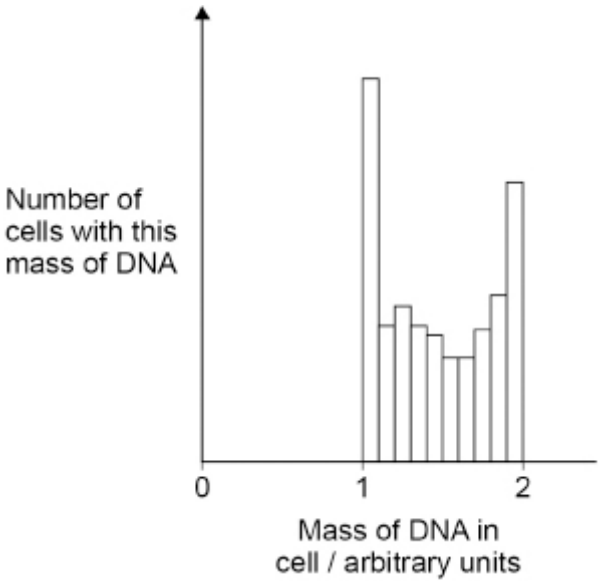
_____

(2)

(Total 9 marks)

Q4.

(a) The figure below shows the mass of DNA present in a group of healthy cells.



Use your knowledge of the cell cycle to explain the results shown in the figure.

(3)

(b) Suggest **one** way the figure above would be different if these cells were tumour cells.

Justify your answer.

_____

_____

_____

_____

_____

_____

(2)

(c) Describe the behaviour of chromosomes in prophase and metaphase of mitosis.

Prophase _____

_____

_____

Metaphase _____

_____

_____

(2)

(d) During anaphase, the spindle exerts 3×10^{-11} N of force on each chromatid. This force generates 6×10^{-19} W of power.

Calculate the speed of movement, in nm s^{-1}, of one chromatid during anaphase using the following equation:

$$P = F \times V$$

Where P = power in W
F = force in N
V = speed in m s^{-1}

Show your working.

Answer _____ nm s^{-1}

(2)

(Total 9 marks)

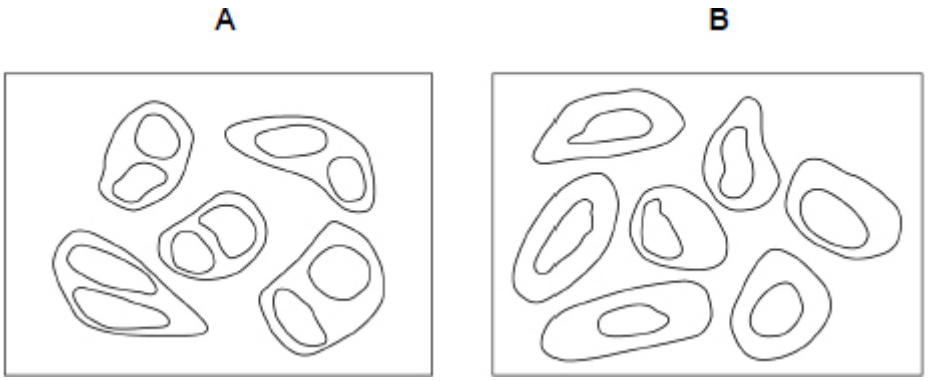
Q5.

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

Figure 1 shows drawings of cancer cells seen with an optical microscope from a:

- sample treated with MiTMAB
- control sample.

Figure 1



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

Explain why.

_____

_____

_____

_____

_____

_____

(2)

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

Suggest how MiTMAB can cause dynamin to become inactive.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

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:

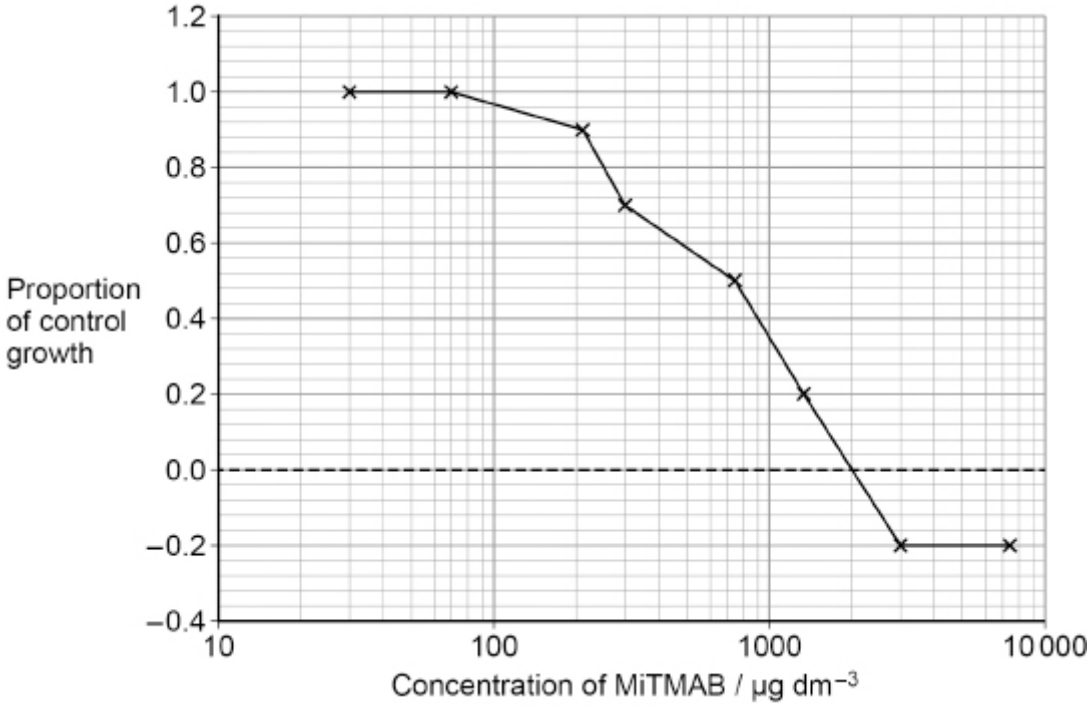
- one sample of 2500 cells without MiTMAB as a control
- eight samples, each with 2500 cells and a different concentration of MiTMAB.

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

Figure 2 shows the scientists' results.

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

Figure 2



(c) Use all the information given to explain the results shown in **Figure 2**.

(3)

(d) 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.

Answer _____ µg

(2)

(Total 10 marks)

Q6.

(a) What is a tumour?

_____

_____

_____

_____

(2)

(b) Describe how you would determine a **reliable** mitotic index (MI) from tissue observed with an optical microscope.

Do **not** include details of how you would prepare the tissue observed with an optical microscope.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 5 marks)

Q7.

(a) Describe viral replication.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(b) Complete the table below by putting a tick (✓) where the feature is part of a cell cycle involving mitosis or a cell cycle involving binary fission.

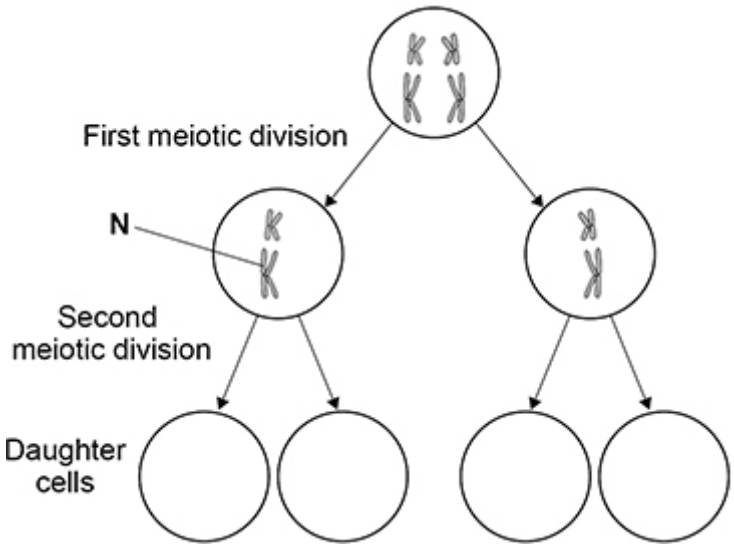
Feature	**Cell cycle involving:**	
	mitosis	**binary fission**
Replication of linear DNA		
Replication of circular DNA		
Produces 2 daughter cells		
Produces 4 daughter cells		
Happens in prokaryotic cells		
Happens in eukaryotic cells		

(2)

Figure 1 represents a cell undergoing meiosis. It shows the chromosomes in the parent cell and in the two cells formed after the first meiotic division.

The second division of meiosis proceeds normally except that non-disjunction occurs in the chromosome labelled **N**.

Figure 1



(c) Complete **Figure 1** to show the chromosomes inside the daughter cells formed after the second meiotic division.

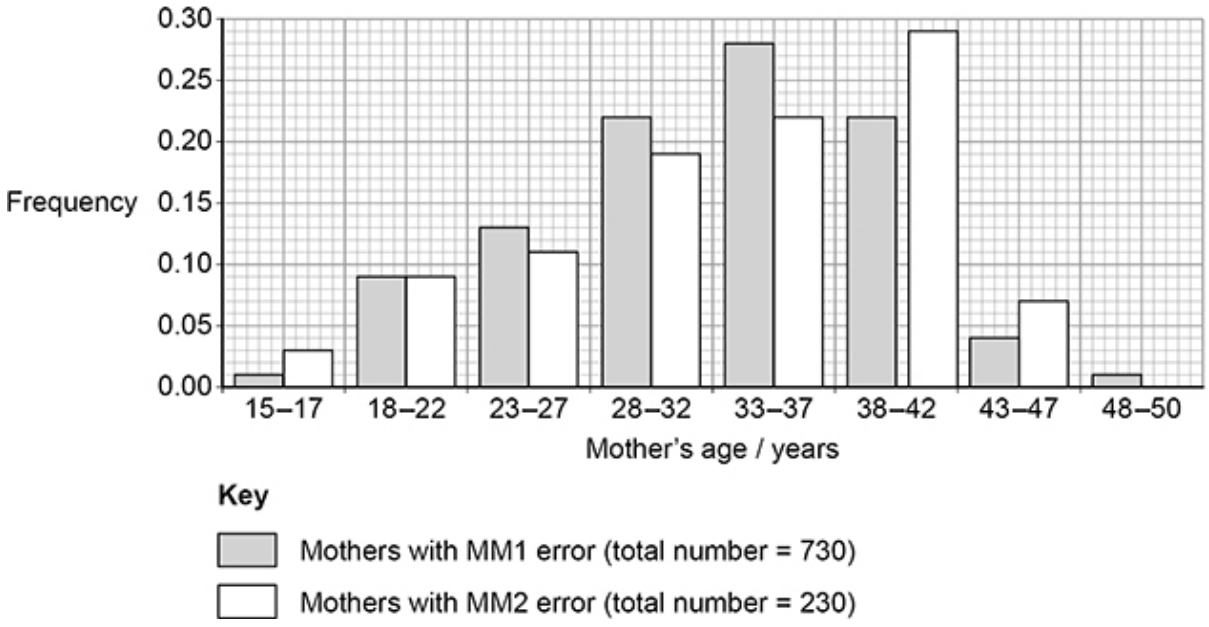
(2)

Doctors studied babies born with a mutation caused by chromosome non-disjunction during gamete formation in their mother.

They determined each mother's age at the time of childbirth and whether the non-disjunction happened in the first meiotic division (MM1 error) or in the second meiotic division (MM2 error).

Figure 2 shows the doctors' results.

Figure 2



(d) A student concluded that there were more mothers of age >37 with MM2 errors than with MM1 errors.

Using **Figure 2** and suitable calculations show why this conclusion is **not** valid.

_____

_____

(2)

(Total 9 marks)

Q8.

A student prepared a stained squash of cells from the root tips of garlic to calculate a mitotic index. He:

1. cut the end 5 mm from 10 garlic roots
2. placed the root tips into a Petri dish containing 5 cm^3 of hydrochloric acid for 12 minutes
3. rinsed the root tips in distilled water
4. placed one of the root tips on a microscope slide and added toluidine blue stain
5. placed a coverslip onto the microscope slide, and gently pressed the coverslip downwards on the root tip
6. observed the root tip using an optical microscope.

(a) Suggest why the student soaked the root tips in hydrochloric acid in step **2**.

_____

_____

_____

_____

_____

_____

_____

_____

(2)

(b) Pressing the coverslip downwards enabled the student to observe the stages of mitosis clearly.

Explain why.

_____

_____

_____

_____

_____

_____

_____

(2)

The diagram below shows the student's drawing of one field of view.

(c) Name the stage of mitosis shown in cell **G**. Explain the appearance of this cell.

Stage of mitosis _____

Explanation _____

_____

_____

_____

_____

(2)

(d) Use the diagram above to calculate a mitotic index for the cells in this field of view.

Mitotic index _____

(1)

(e) Other students in the class followed the same method, but calculated different mitotic indices.

Apart from student errors, suggest **two** explanations why.

1 _____

_____

_____

2 _____

_____

_____

(2)

(Total 9 marks)