

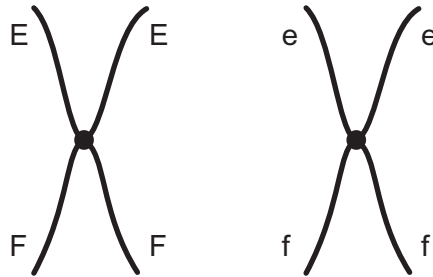
# Cell Division Questions

## Mitosis and Meiosis

1

5 **Figure 3** shows a pair of chromosomes at the start of meiosis. The letters represent alleles.

**Figure 3**



5 (a) What is an allele?

.....

.....

(1 mark)

5 (b) Explain the appearance of one of the chromosomes in **Figure 3**.

.....

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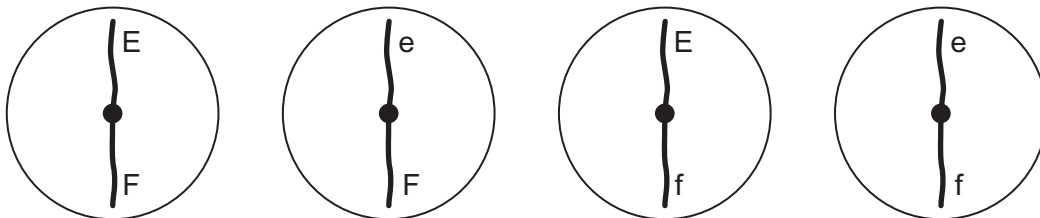
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(2 marks)

5 (c) The cell containing this pair of chromosomes divided by meiosis. **Figure 4** shows the distribution of chromosomes from this pair in four of the gametes produced.

**Figure 4**



5 (c) (i) Some of the gametes formed during meiosis have new combinations of alleles. Explain how the gametes with the combinations of alleles Ef and eF have been produced.

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(2 marks)

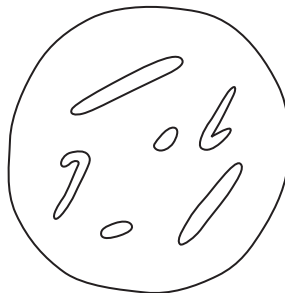
5 (c) (ii) Only a few gametes have the new combination of alleles Ef and eF. Most gametes have the combination of alleles EF and ef. Suggest why only a few gametes have the new combination of alleles, Ef and eF.

.....  
.....

(1 mark)

5 (d) Figure 5 shows a cell with six chromosomes.

Figure 5



5 (d) (i) This cell produces gametes by meiosis. Draw a diagram to show the chromosomes in one of the gametes.

(2 marks)

5 (d) (ii) How many different types of gametes could be produced from this cell as a result of different combinations of maternal and paternal chromosomes? (1 mark)

□

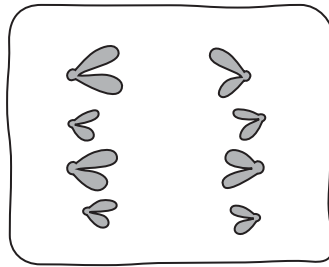
□  
9

Turn over ►



2

2 (a) The diagram shows a stage of mitosis in an animal cell.



2 (a) (i) Name this stage.

..... (1 mark)

2 (a) (ii) Describe what happens during this stage that results in the production of two genetically identical cells.

.....  
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..... (2 marks)

2 (b) A sample of epithelial tissue from the small intestine of an animal was analysed. Some of the cells had 8.4 units of DNA, others had only 4.2 units.

2 (b) (i) Use your knowledge of the cell cycle to explain why some cells had 8.4 units of DNA and others had only 4.2 units.

.....  
.....  
.....  
.....  
..... (2 marks)



**2 (b) (ii)** How many units of DNA would you expect to be present in a gamete formed in this animal as a result of meiosis?

(1 mark)

6

**Turn over for the next question**

**Turn over ►**



3

4 (a) Mitosis is important in the life of an organism. Give **two** reasons why.

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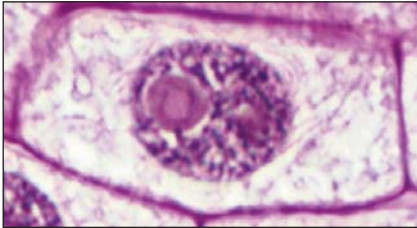

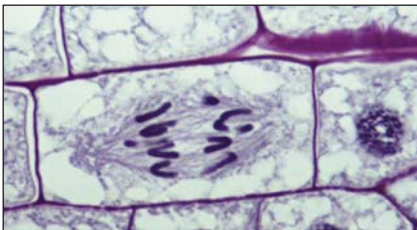
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(2 marks)

A biologist used a microscope to investigate plant tissue where some of the cells were dividing by mitosis. She examined 200 cells and counted the number of cells in interphase and in each stage of mitosis.

The table shows some of the cells she saw, and the percentage of cells in interphase and in two stages of mitosis, **A** and **B**.

Stage of cell cycle	Percentage of cells
Interphase 	90
Stage A 	3
Stage B 	1



4 (b) (i) Explain why the biologist chose to examine 200 cells.

.....  
.....  
.....

(1 mark)

4 (b) (ii) Name Stage **A** and Stage **B**. Give the evidence from the photograph that you used to identify the stage.

Name of Stage **A** .....

Evidence .....

.....

Name of Stage **B** .....

Evidence .....

.....

(4 marks)

4 (c) In this tissue one complete cell cycle took 20 hours.  
Using information from the table, calculate the mean time for these cells to complete mitosis. Show your working.

Answer .....

(2 marks)

9

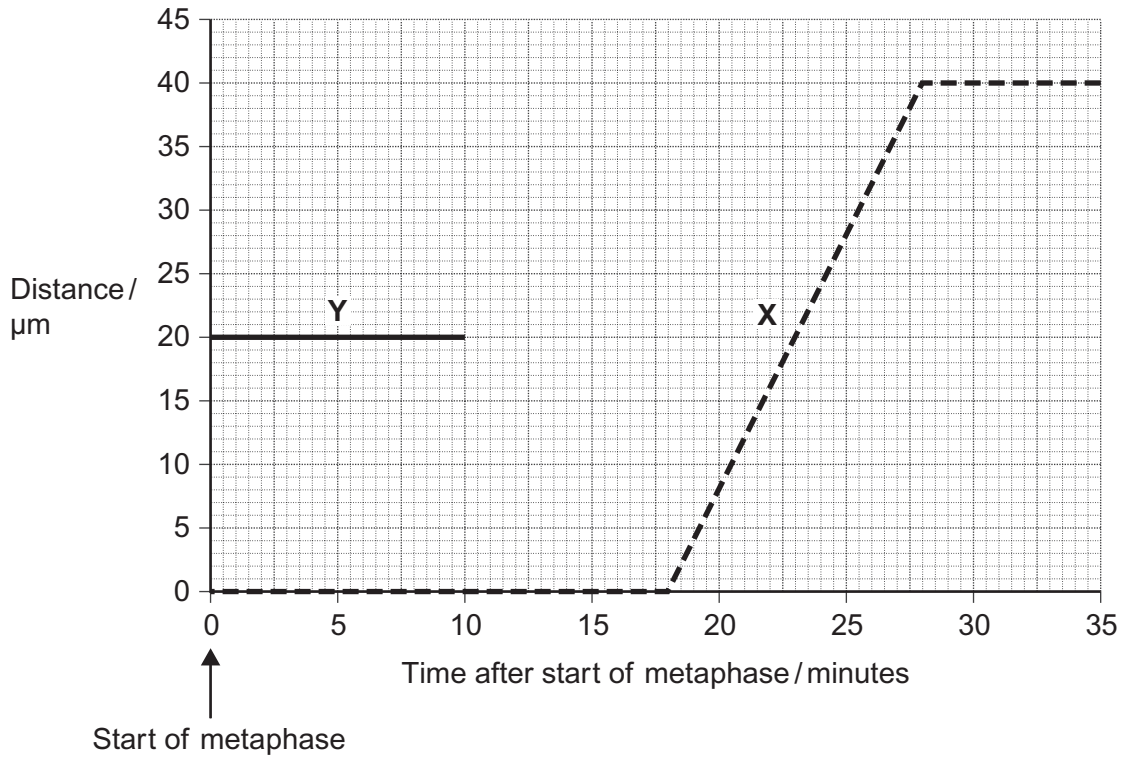
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8 (b) The graph shows information about the movement of chromatids in a cell that has just started metaphase of mitosis.

**Key**

- - - = distance between chromatids
- = distance between each chromatid and the pole to which it is moving



8 (b) (i) What was the duration of metaphase in this cell?

minutes

(1 mark)

8 (b) (ii) Use line X to calculate the duration of anaphase in this cell.

minutes

(1 mark)

8 (b) (iii) Complete line Y on the graph.

(2 marks)





8 (c) A doctor investigated the number of cells in different stages of the cell cycle in two tissue samples, **C** and **D**. One tissue sample was taken from a cancerous tumour. The other was taken from non-cancerous tissue. The table shows his results.

Stage of the cell cycle	Percentage of cells in each stage of the cell cycle	
	Tissue sample <b>C</b>	Tissue sample <b>D</b>
Interphase	82	45
Prophase	4	16
Metaphase	5	18
Anaphase	5	12
Telophase	4	9

8 (c) (i) In tissue sample **C**, one cell cycle took 24 hours. Use the data in the table to calculate the time in which these cells were in interphase during one cell cycle. Show your working.

Time cells in interphase ..... hours  
(2 marks)

8 (c) (ii) Explain how the doctor could have recognised which cells were in interphase when looking at the tissue samples.

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.....  
.....

(1 mark)

8 (c) (iii) Which tissue sample, **C** or **D**, was taken from a cancerous tumour? Use information in the table to explain your answer.

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(2 marks)

15

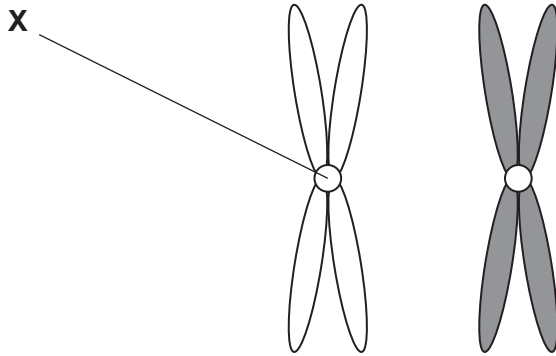
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Answer **all** questions in the spaces provided.

5 1 (a) **Figure 1** shows one pair of homologous chromosomes.

**Figure 1**



1 (a) (i) Name **X**.

..... (1 mark)

1 (a) (ii) Describe the role of **X** in mitosis.

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..... (2 marks)

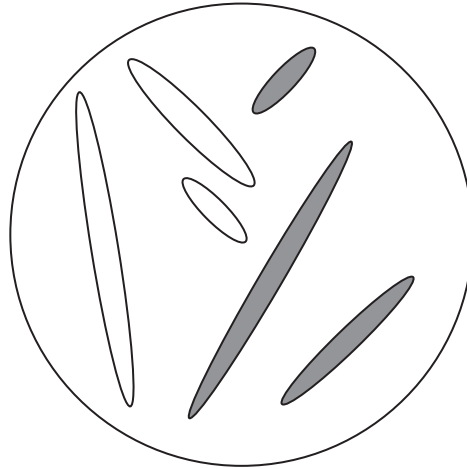
1 (a) (iii) Homologous chromosomes carry the same genes but they are **not** genetically identical. Explain why.

.....  
.....  
..... (1 mark)



1 (b) **Figure 2** shows three pairs of homologous chromosomes in a cell at the end of cell division.

**Figure 2**



1 (b) (i) The appearance of each chromosome in **Figure 2** is different from those shown in **Figure 1**. Explain why.

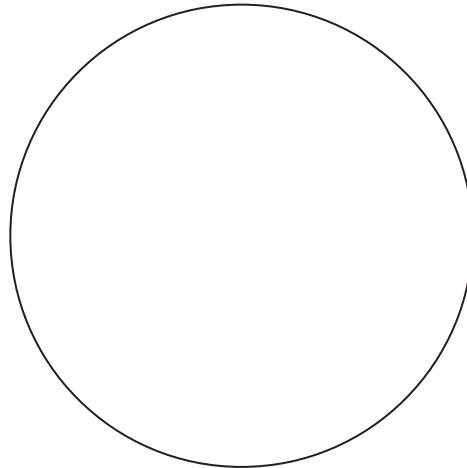
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(1 mark)

1 (b) (ii) Complete the diagram to show the chromosomes in one cell that could be produced from the cell in **Figure 2** as a result of meiosis.



(2 marks)

1 (b) (iii) Other than independent segregation, give **one** way in which meiosis allows the production of genetically different cells.

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.....

.....

(1 mark)





Scientists investigated three genes, **C**, **D** and **E**, involved in controlling cell division. They studied the effect of mutations in these genes on the risk of developing lung cancer.

The scientists analysed genes **C**, **D** and **E** from healthy people and people with lung cancer.

- If a person had a normal allele for a gene, they used the symbol N.
- If a person had two mutant alleles for a gene, they used the symbol M.

They used their data to calculate the risk of developing lung cancer for people with different combinations of N and M alleles of the genes. A risk value of 1.00 indicates no increased risk. **Table 7** shows the scientists' results.

**Table 7**

Gene C	Gene D	Gene E	Risk of developing lung cancer
N	N	N	1.00
M	N	N	1.30
N	N	M	1.78
N	M	N	1.45

N = at least one copy of the normal allele is present  
M = two copies of the mutant allele are present

**8 (b)** What do these data suggest about the relative importance of the mutant alleles of genes **C**, **D** and **E** on **increasing** the risk of developing lung cancer? Explain your answer.

**[3 marks]**

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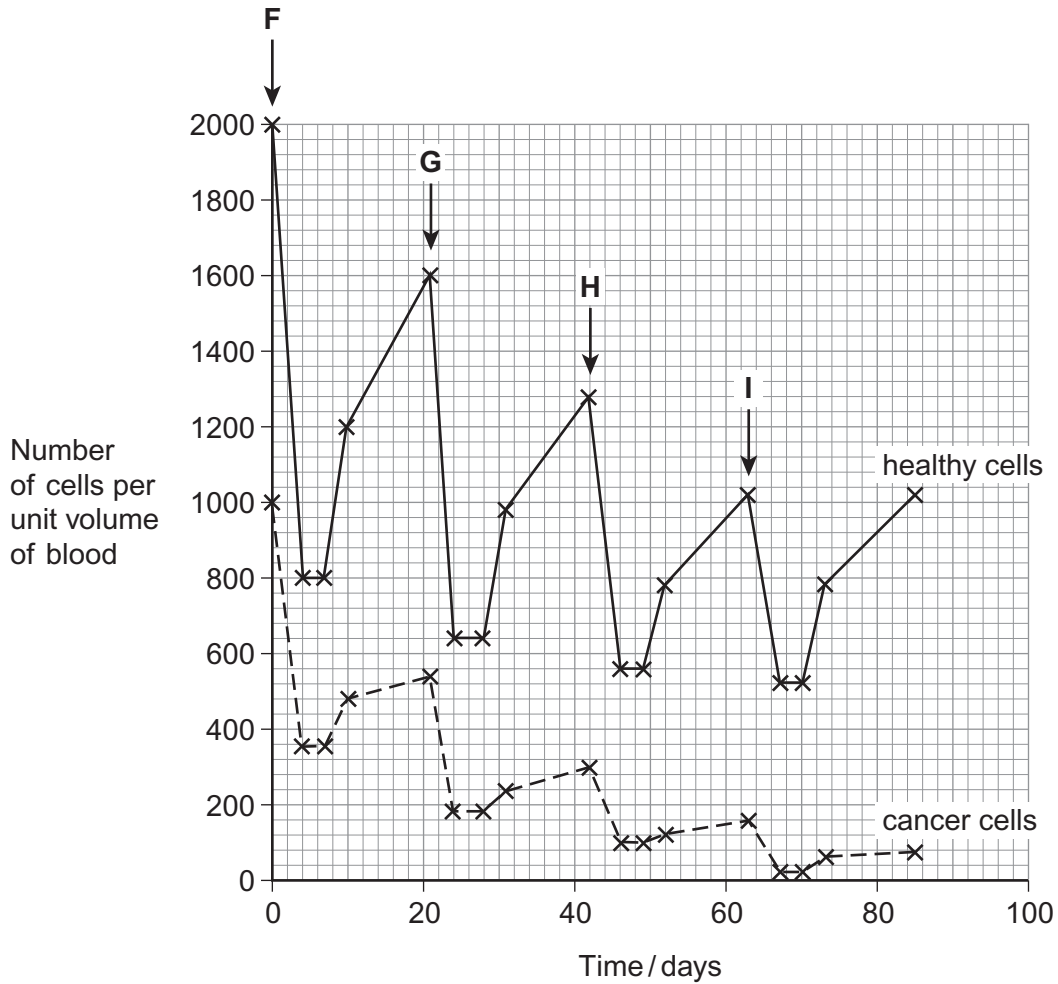
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**Turn over ►**



Chemotherapy is the use of a drug to treat cancer. The drug kills dividing cells. **Figure 5** shows the number of healthy cells and cancer cells in the blood of a patient receiving chemotherapy. The arrows labelled **F** to **I** show when the drug was given to the patient.

**Figure 5**



**8 (c)** Calculate the rate at which healthy cells were killed between days 42 and 46. [1 mark]

[1 mark]

..... cells killed per unit volume of blood per day



**8 (d)** Describe similarities and differences in the response of healthy cells and cancer cells to the drug between times **F** and **G**.

**[3 marks]**

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**[Extra space]** .....

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**8 (e)** More cancer cells could be destroyed if the drug was given more frequently.  
Suggest why the drug was **not** given more frequently.

**[2 marks]**

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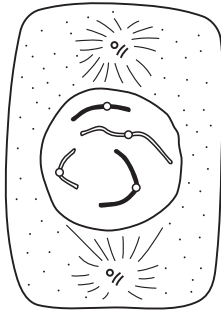
**Turn over for the next question**

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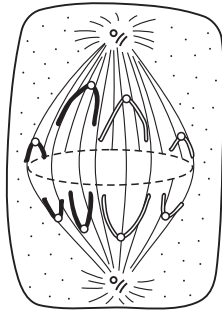


Answer **all** questions in the spaces provided.

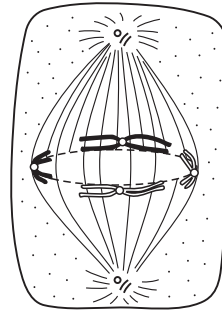
- 7 1 (a) (i) The diagrams show some of the stages of mitosis. Arrange the letters **A - D** to give the correct sequence of stages.



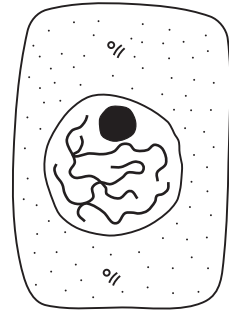
**A**



**B**



**C**



**D**

Sequence ..... (1 mark)

- (ii) Describe the role of the spindle in mitosis.

.....  
 .....  
 .....  
 .....

(2 marks)

- (b) Sexual reproduction involves the fusion of gametes. Explain the importance of meiosis in the life cycle of a sexually reproducing organism.

.....  
 .....  
 .....  
 .....

(2 marks)



(c) The table shows the mean mass of DNA in the nuclei of different cells in cattle.

Cell	Mean mass of DNA/ arbitrary units
Sperm cell	3.42
Red blood cell	0.00
Liver cell	7.05

(i) Explain the difference in DNA content between sperm and liver cells.

.....  
.....  
(1 mark)

(ii) There is no DNA in the red blood cell. Explain why.

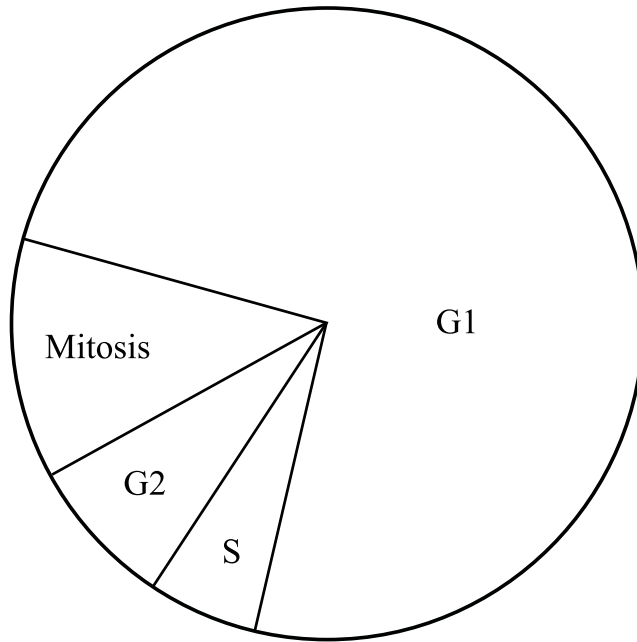
.....  
.....  
(1 mark)

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—  
7

**TURN OVER FOR THE NEXT QUESTION**

Turn over ►

2 The diagram shows some of the different stages in the cell cycle.



- (a) There are 20 units of DNA in a cell during stage G2. Give the number of units of DNA you would expect to find in this cell
- (i) at prophase of mitosis; .....
  - (ii) in one of the daughter cells produced at the end of mitosis; .....
  - (iii) during stage G1. ....
- (3 marks)*

(b) Vincristine is a drug used in the treatment of cancer. It prevents spindle formation during mitosis.

- (i) Explain how treatment with vincristine will affect the behaviour of chromosomes during mitosis.

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*(2 marks)*

- (ii) People who are given vincristine to treat cancer have a reduced number of red blood cells. Suggest a reason for this.

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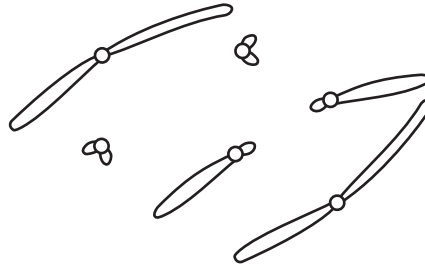
*(1 mark)*

**Turn over** ▶

9 2 (a) Give **one** process which occurs in the nucleus of a cell during interphase which is necessary before cell division can take place.

.....  
(1 mark)

(b) The diagram shows the chromosomes from a cell with a diploid chromosome number of six.



Draw a diagram to show the chromosomes from one of the resulting cells if

(i) the cell divides by **mitosis**;

(2 marks)

(ii) the cell divides by **meiosis**.

(2 marks)

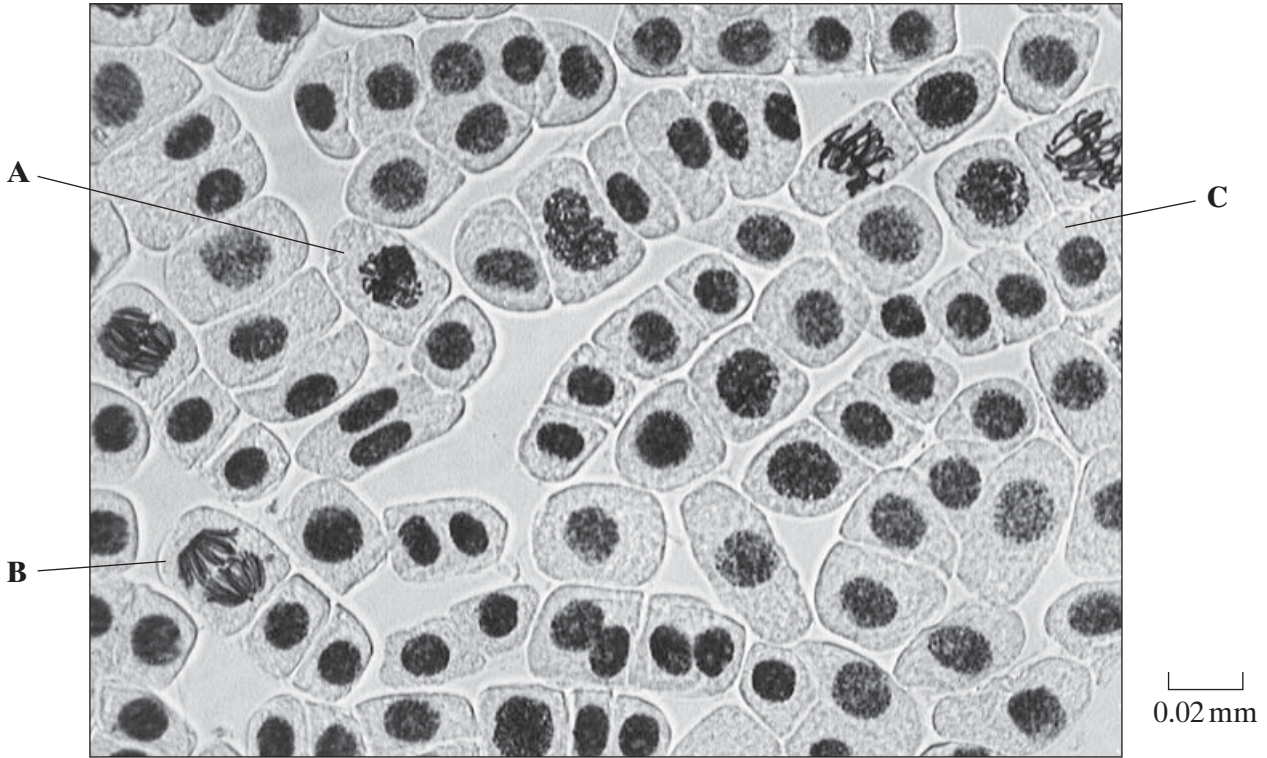
(c) Explain **one** advantage of cells lining the human gut dividing very frequently.

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(1 mark)

Turn over ▶

Answer **all** questions in the spaces provided.

- 10 1 The photograph shows cells from an onion root tip. The root tip has been squashed and stained to show the stages of mitosis.



- (a) (i) At what stage of mitosis is cell **A**?

.....  
(1 mark)

- (ii) What is the evidence that cell **B** is in anaphase?

.....  
.....  
(1 mark)

- (iii) Cell **C** is in interphase. Give **two** processes which occur during interphase that enable cell division to occur.

1 .....

.....

2 .....

.....

(2 marks)  
20

- (b) Explain how you would calculate the magnification of the photograph.

.....  
 .....

(1 mark)

- (c) The number of cells at each stage of mitosis was counted. The results are shown in the table.

Stage of mitosis	Number of cells
Interphase	123
Prophase	32
Metaphase	12
Anaphase	6
Telophase	27

One complete cell cycle takes 24 hours. The number of cells at each stage is proportional to the time spent at that stage. Calculate the length of time spent in metaphase. Show your working.

Answer ..... hours.  
(2 marks)

7

**TURN OVER FOR THE NEXT QUESTION**

Turn over 

4 A student investigated the stages of mitosis in a garlic root. The root tip was placed on a microscope slide with a stain. A cover slip was placed on top and the root tip was firmly squashed.

(a) Explain why

(i) a root tip was used;

.....  
 .....  
 (1 mark)

(ii) a stain was used;

.....  
 .....  
 (1 mark)

(iii) the root tip was firmly squashed.

.....  
 .....  
 (1 mark)

(b) The student examined the cells in the garlic root tip under the microscope, and obtained the following data.

Stage	Number of cells
Interphase	872
Prophase	74
Metaphase	18
Anaphase	10
Telophase	8

(i) Calculate the percentage of these cells in which the chromosomes are visible and would consist of a pair of chromatids joined together. Show your working.

Answer .....  
 (2 marks)

(ii) A different set of results was obtained when the count was repeated on another occasion with a different garlic root tip. Give **two** reasons for the difference in results.

1 .....

.....

2 .....

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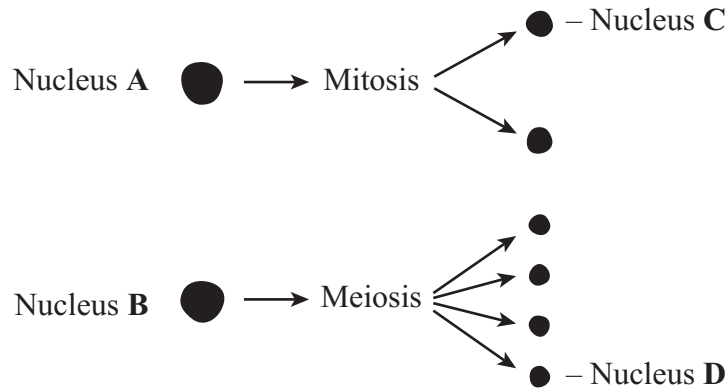
(2 marks)



**TURN OVER FOR THE NEXT QUESTION**

Turn over   
23

- 12 3 (a) Nucleus **A** and nucleus **B** come from the same organism. The diagram shows these nuclei immediately before division and the nuclei formed immediately after their division. The table gives information about some of the nuclei shown in the diagram.



Nucleus	Number of chromosomes	Mass of DNA / arbitrary units
<b>A</b>	8	600
<b>B</b>	8	600
<b>C</b>		
<b>D</b>		

Complete the table for nuclei **C** and **D**.

(2 marks)

- (b) A student investigated the process of meiosis by observing cells on a microscope slide. The cells on the slide had been stained.

- (i) Name an organ from which the cells may have been obtained.

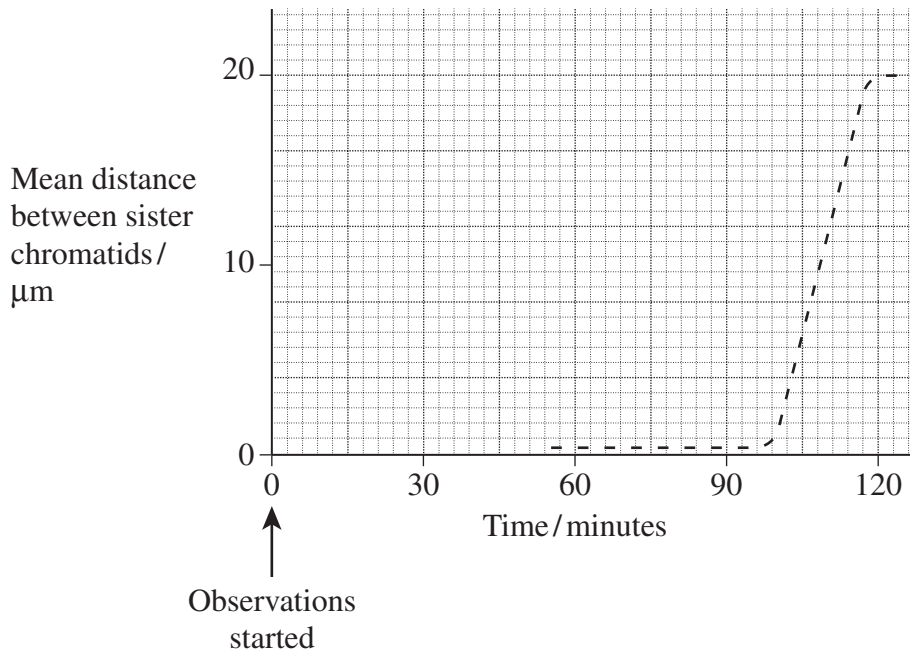
.....  
(1 mark)

- (ii) Explain why a stain was used.

.....  
.....  
(1 mark)



13 3 An investigator observed a cell during part of one cell cycle. The graph shows the mean distance between sister chromatids.



(a) (i) At what time did anaphase start?

..... minutes (1 mark)

(ii) Explain the evidence from the graph that supports your answer.

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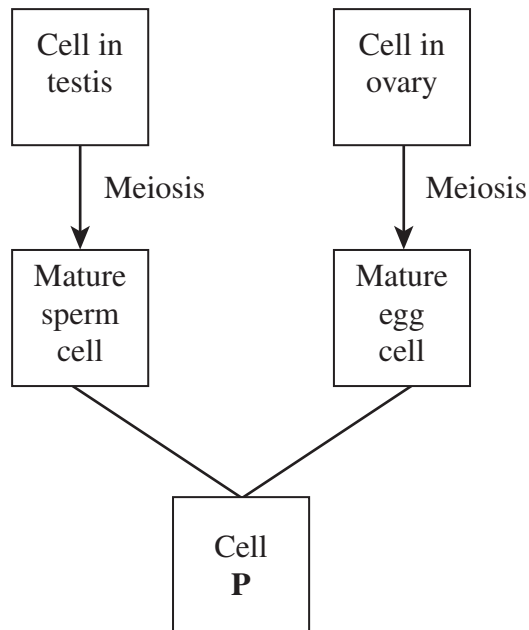
(2 marks)

(b) The investigator was not able to obtain measurements between 0 and 60 minutes. Use your knowledge of the cell cycle to explain why.

.....  
 .....  
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(2 marks)

(c) The diagram summarises gamete formation and fertilisation in humans.



(i) Name cell **P**.

.....  
(1 mark)

(ii) Meiosis halves the chromosome number. Explain why this is important.

.....  
.....  
(1 mark)

7

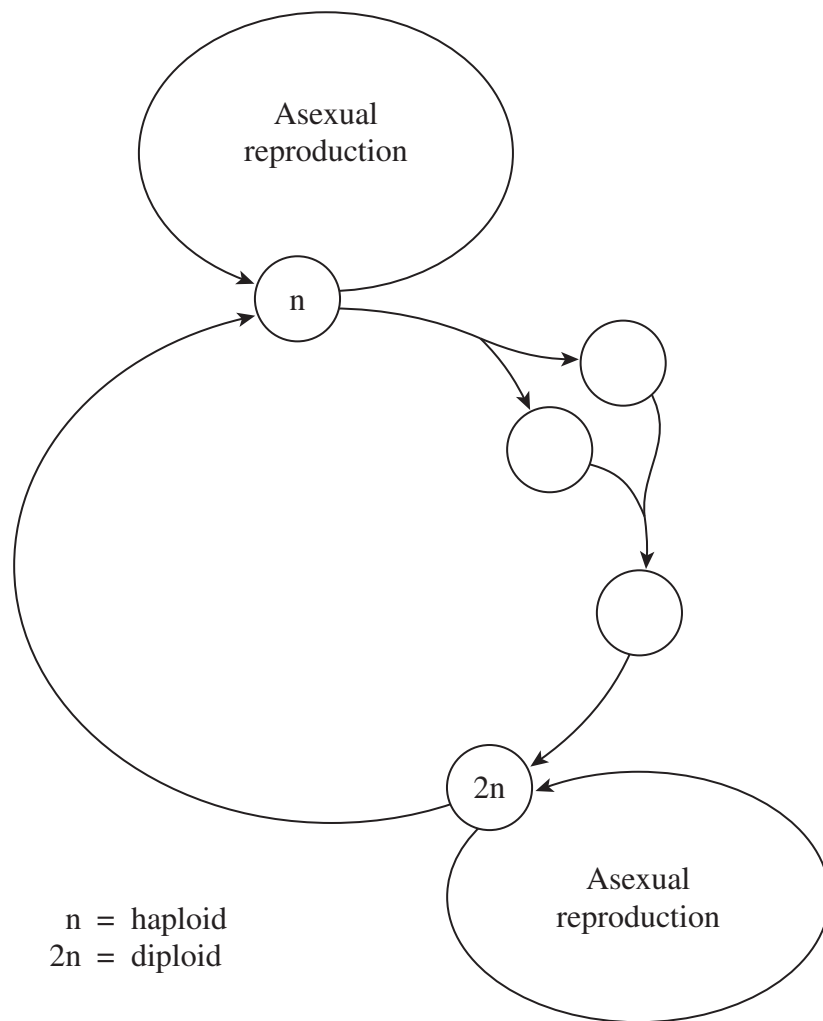
**Turn over for the next question**

14 2 (a) Describe the role of the following structures in mitosis.

- (i) Centromere .....
- .....
- (ii) Spindle fibres .....
- .....

(2 marks)

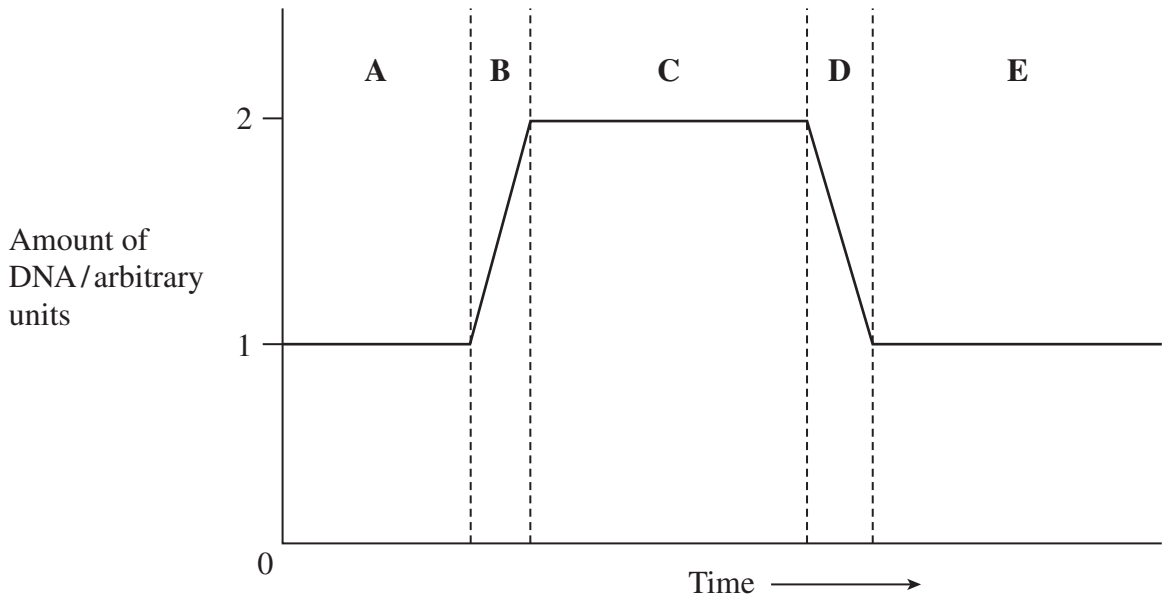
(b) Yeast is a single-celled organism. It can reproduce sexually or asexually. The diagram shows the life cycle of yeast.



- (i) The diagram shows some haploid stages and some diploid stages. Complete the diagram to show the stages that are haploid and the stages that are diploid. Write 'n' in the appropriate circle to show a haploid stage and '2n' to show a diploid stage. (1 mark)
- (ii) Write 'X' on the appropriate arrow to show the stage in which yeast divides by meiosis. (1 mark)

(1 mark)  
27  
Turn over ►

15 2 The graph shows changes in the amount of DNA in a cell during one cell cycle.



(a) Name the phase of the cell cycle that occurs during time period **B**.

.....  
(1 mark)

(b) Many drugs that are used to treat cancer work at different time periods during the cell cycle.

(i) Cisplatin binds to DNA, and stops free DNA nucleotides joining together. In which time period, **A** to **E**, would you expect cisplatin to have the greatest effect? Explain your answer.

Time period .....

Explanation .....

.....  
(2 marks)

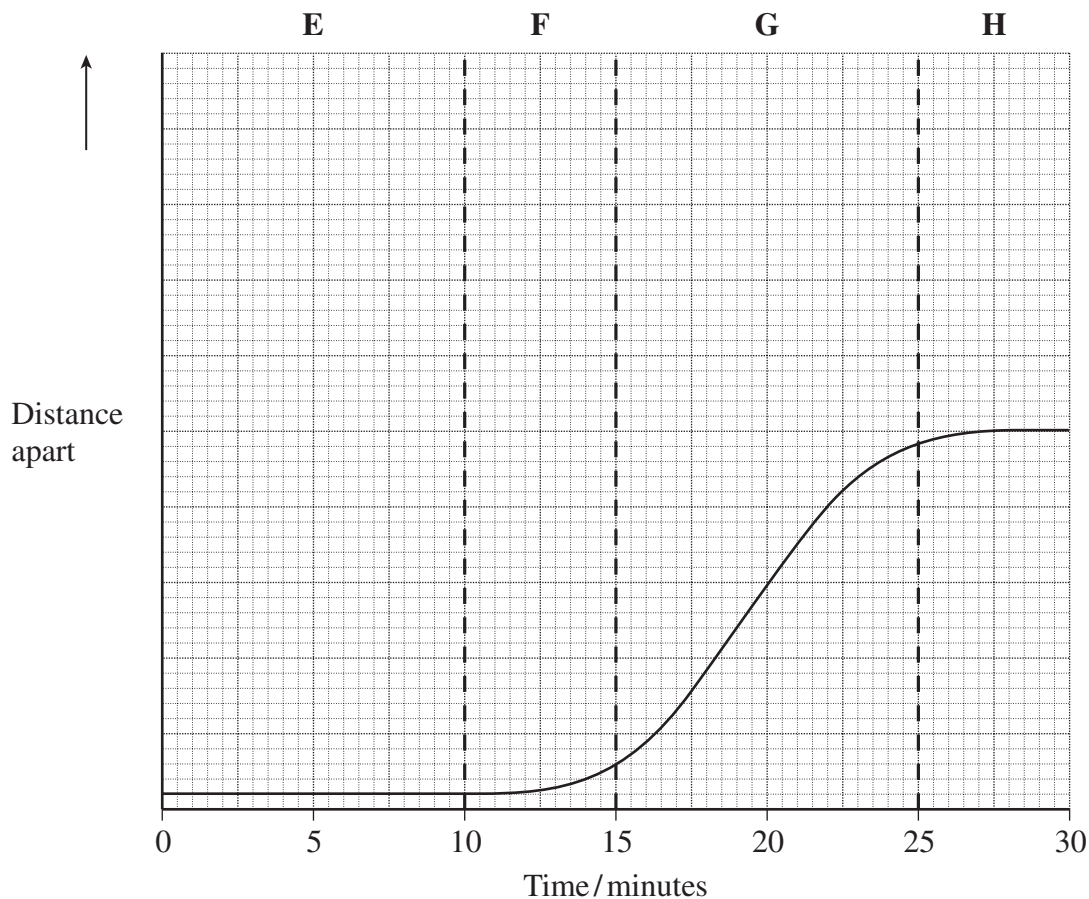
(ii) A different drug stops spindle fibres shortening. This drug has its greatest effect during time period **D**. Explain why.

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(2 marks)

- 16 3 (b) During mitosis chromosomes line up on the equator of the cell. Each chromosome consists of a pair of chromatids. Each chromatid then moves towards a pole of the cell.

The graph shows how the distance between a centromere and the equator of the cell changes during mitosis.



- 3 (b) (i) Sketch a curve on the graph to show the change in the distance apart of the centromeres on a pair of chromatids during this mitotic division. (2 marks)

- 3 (b) (ii) What phase of mitosis is represented by stage **H** on the graph?

.....  
(1 mark)

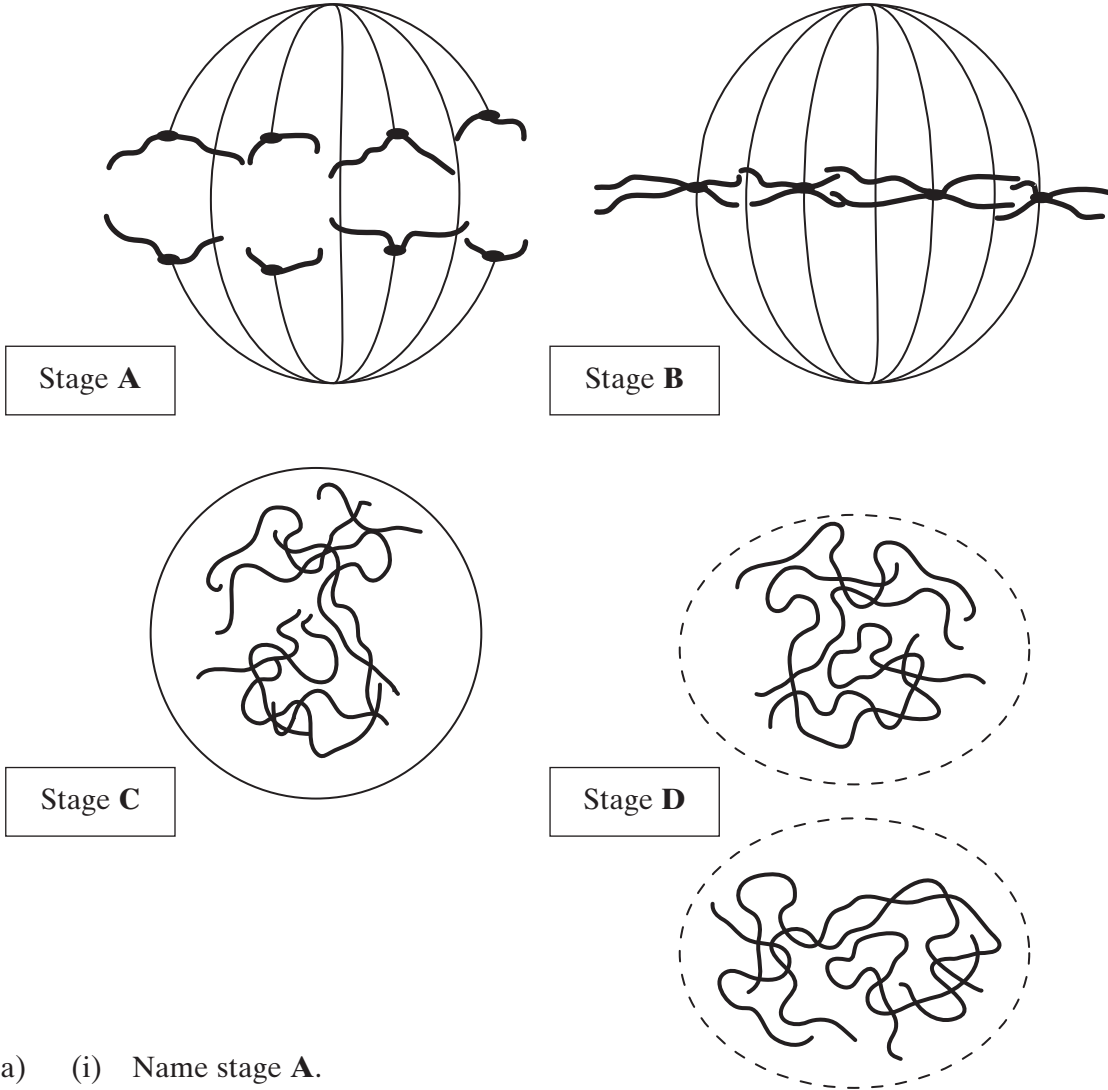
- 3 (b) (iii) What causes the distance between the centromere and the equator to change during stage **G**?

.....  
.....  
(1 mark)



Answer **all** questions in the spaces provided.

17 1 The diagrams show four stages of mitosis.



(a) (i) Name stage **A**.

.....

(1 mark)

(ii) Starting with stage **C**, give the stages **A** to **D** in the correct order.

**C** ..... ..

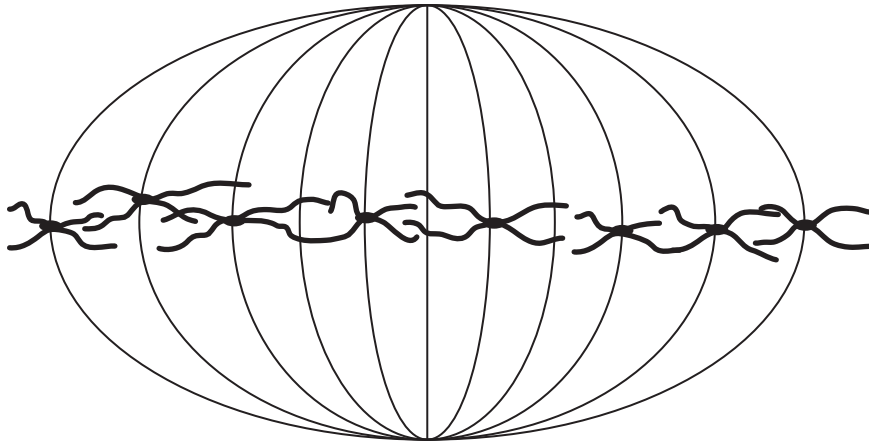
(1 mark)

(iii) Describe and explain the appearance of one of the chromosomes in stage **B**.

.....  
 .....  
 .....  
 .....

(2 marks)  
30

- (b) Colchicine is a substance that prevents the formation of the spindle in mitosis. Dividing cells were treated with colchicine. This stopped them dividing. After a few hours, the colchicine was removed and the cells began to divide again. The diagram shows the chromosomes from one of the treated cells at stage **B** after the cell began dividing again.



- (i) What has happened to the chromosome number?

.....  
(1 mark)

- (ii) Suggest an explanation for the change in the chromosome number.

.....  
.....  
(1 mark)

6

**TURN OVER FOR THE NEXT QUESTION**

Turn over 

- 18 2 (a) Explain the importance of meiosis in the life cycles of organisms which reproduce sexually.

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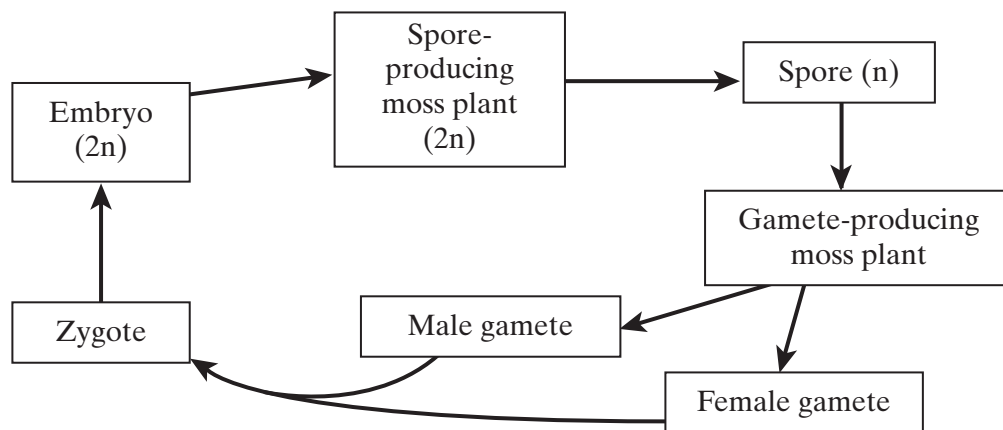
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(3 marks)

- (b) The diagram shows the life cycle of a moss plant.

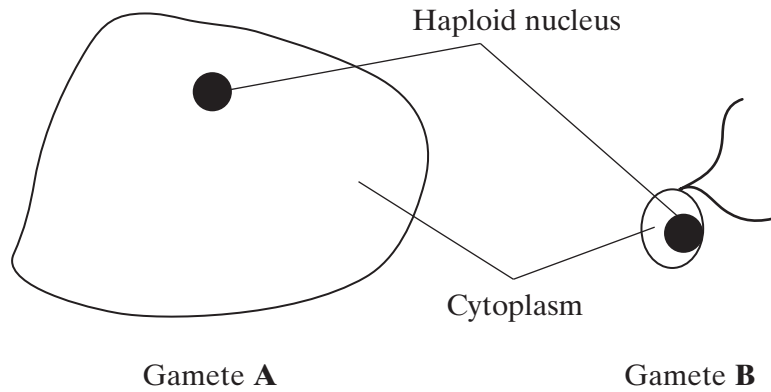


On the diagram mark with an **M** where meiosis takes place.

(1 mark)



(c) The diagrams show the male and female gametes of the moss, drawn to the same scale.



Which gamete is the male? Give **two** reasons for your answer.

Male gamete.....

- 1 .....
- .....
- 2 .....
- .....

(2 marks)

6

**TURN OVER FOR THE NEXT QUESTION**

Turn over

- 19 4 (a) During meiosis, one chromosome from each homologous pair goes to each of the cells produced. Explain why this is important.

.....

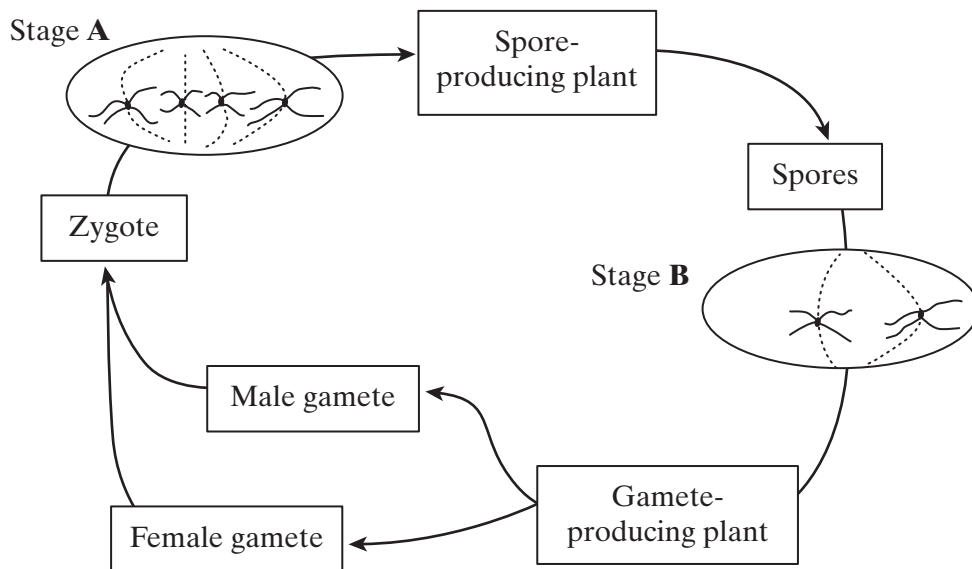
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(2 marks)

- (b) The diagram shows the life cycle of a fern plant. Drawings of the chromosomes during cell division are shown for the stages that give the spore-producing plant and the gamete-producing plant.



- (i) What is the diploid number of chromosomes in this fern plant?

.....

(1 mark)

- (ii) Explain the difference in the number of chromosomes at stages **A** and **B**.

.....

.....

(1 mark)

(iii) Are the male and female gametes produced by mitosis or meiosis? Explain your answer.

.....

.....

.....

.....

(2 marks)

6

**TURN OVER FOR THE NEXT QUESTION**

Turn over   
35

202 (a) The drawing shows a stage of mitosis in an animal cell.



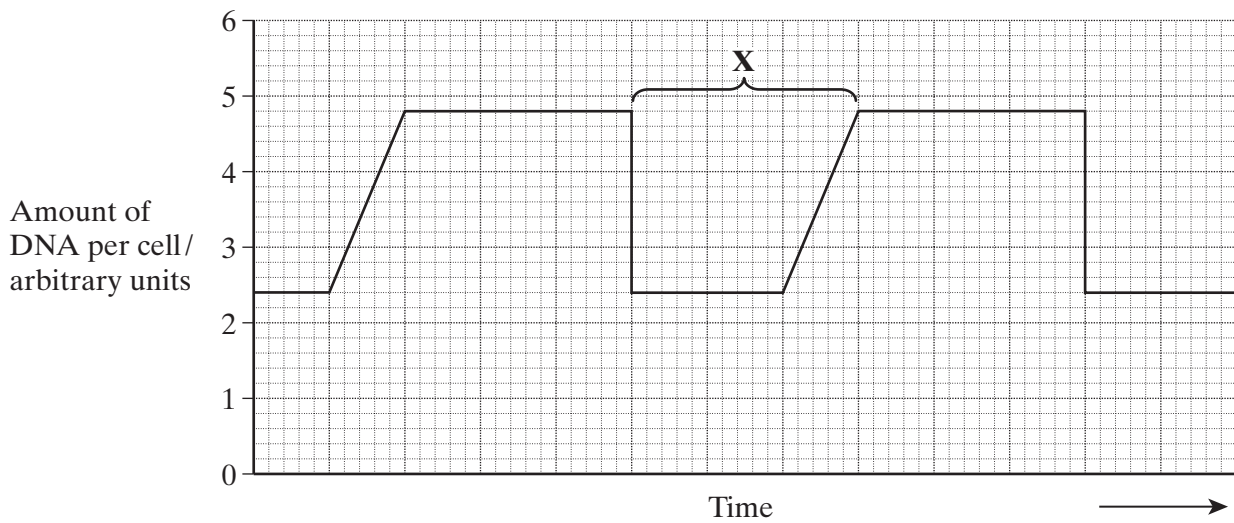
(i) Name this stage of mitosis.

.....  
(1 mark)

(ii) Describe and explain what happens during this stage which ensures that two genetically identical cells are produced.

.....  
.....  
.....  
.....  
(2 marks)

(b) The graph shows the relative amounts of DNA per cell during two successive cell divisions in an animal.



(i) What stage of the cell cycle is shown by **X**?

.....  
 .....  
 (1 mark)

(ii) Apart from an increase in the amount of DNA, give **one** process which occurs during stage **X** which enables nuclear division to occur.

.....  
 .....  
 (1 mark)

(iii) How many units of DNA would you expect to be present in a gamete formed in this animal as a result of meiosis?

.....  
 (1 mark)

(c) The table shows the average duration of each stage of the cell cycle in the cells of a mammalian embryo.

Stage	Mean duration/ minutes
Interphase	12
Prophase	50
Metaphase	15
Anaphase	10
Telophase	42

Give **one** piece of evidence from the table which indicates that these cells are multiplying rapidly.

.....  
 .....  
 (1 mark)

7

Turn over 

21 2 (a) Boxes A to E show some of the events of the cell cycle.

**A** Chromatids separate

**B** Nuclear envelope disappears

**C** Cytoplasm divides

**D** Chromosomes condense and become visible

**E** Chromosomes on the equator of the spindle

(i) List these events in the correct order, starting with **D**.

**D** .....  
.....

(1 mark)

(ii) Name the stage described in box **E**.

.....  
.....

(1 mark)

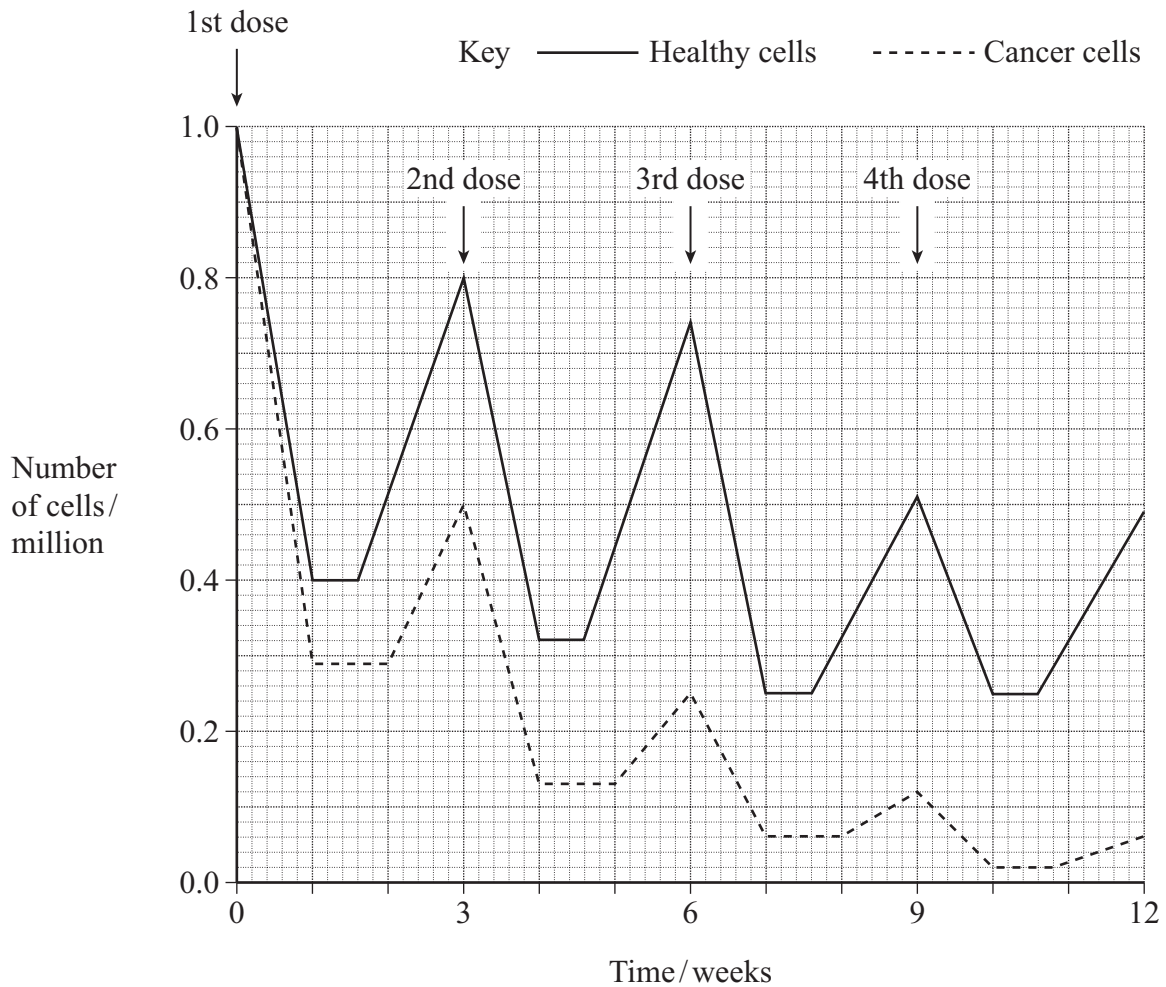
(b) Name the phase during which DNA replication occurs.

.....  
.....

(1 mark)

**Question 2 continues on the next page**

- (c) Bone marrow cells divide rapidly. As a result of a mutation during DNA replication, a bone marrow cell may become a cancer cell and start to divide in an uncontrolled way. A chemotherapy drug that kills cells when they are dividing was given to a cancer patient. It was given once every three weeks, starting at time 0. The graph shows the changes in the number of healthy bone marrow cells and cancer cells during twelve weeks of treatment.



- (i) Using the graph calculate the number of cancer cells present at week 12 as a percentage of the original number of cancer cells. Show your working.

Answer ..... %  
(2 marks)

- (ii) Suggest **one** reason for the lower number of cancer cells compared to healthy cells at the end of the first week.

.....  
.....  
(1 mark)

- (iii) Describe **two** differences in the effect of the drug on the cancer cells, compared with healthy cells in the following weeks.

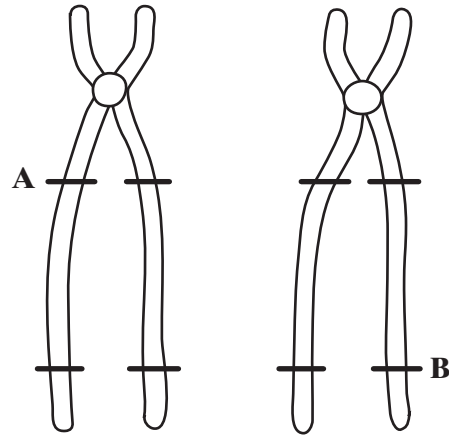
1 .....  
.....  
2 .....  
.....  
(2 marks)

8
---

**Turn over for the next question**



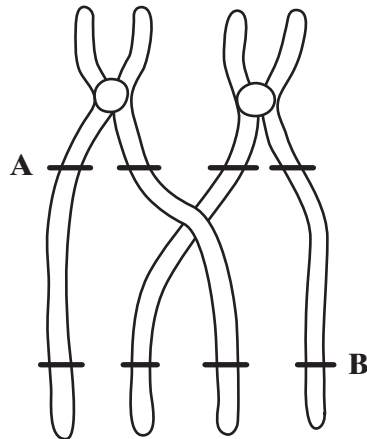
- 22 8 Two pairs of alleles **A** and **a**, and **B** and **b** are found on one pair of homologous chromosomes. A person has the genotype **AaBb**. **Figure 1** shows the chromosomes at an early stage of meiosis. The position of two of the alleles is shown.



**Figure 1**

- (a) Complete **Figure 1** to show the alleles present at the other marked positions. (1 mark)

Crossing over occurs as shown in **Figure 2**.



**Figure 2**

- (b) What term is used to describe the pair of homologous chromosomes shown in **Figure 2**?

..... (1 mark)

(c) From **Figure 2**, give the genotypes of the gametes produced containing the chromatids

(i) that have **not** crossed over;

.....

(ii) that have crossed over.

.....

(2 marks)

(d) Give **two** processes, other than crossing over, which result in genetic variation. Explain how each process contributes to genetic variation.

Process .....

Explanation .....

.....

(2 marks)

Process .....

Explanation .....

.....

(2 marks)

8

**TURN OVER FOR THE NEXT QUESTION**

Turn over 

- 23 2 (a) Boxes A to E show some of the events of the cell cycle.

**A** Chromatids separate

**B** Nuclear envelope disappears

**C** Cytoplasm divides

**D** Chromosomes condense and become visible

**E** Chromosomes on the equator of the spindle

- (i) List these events in the correct order, starting with **D**.

**D** .....  
.....

(1 mark)

- (ii) Name the stage described in box **E**.

.....

(1 mark)

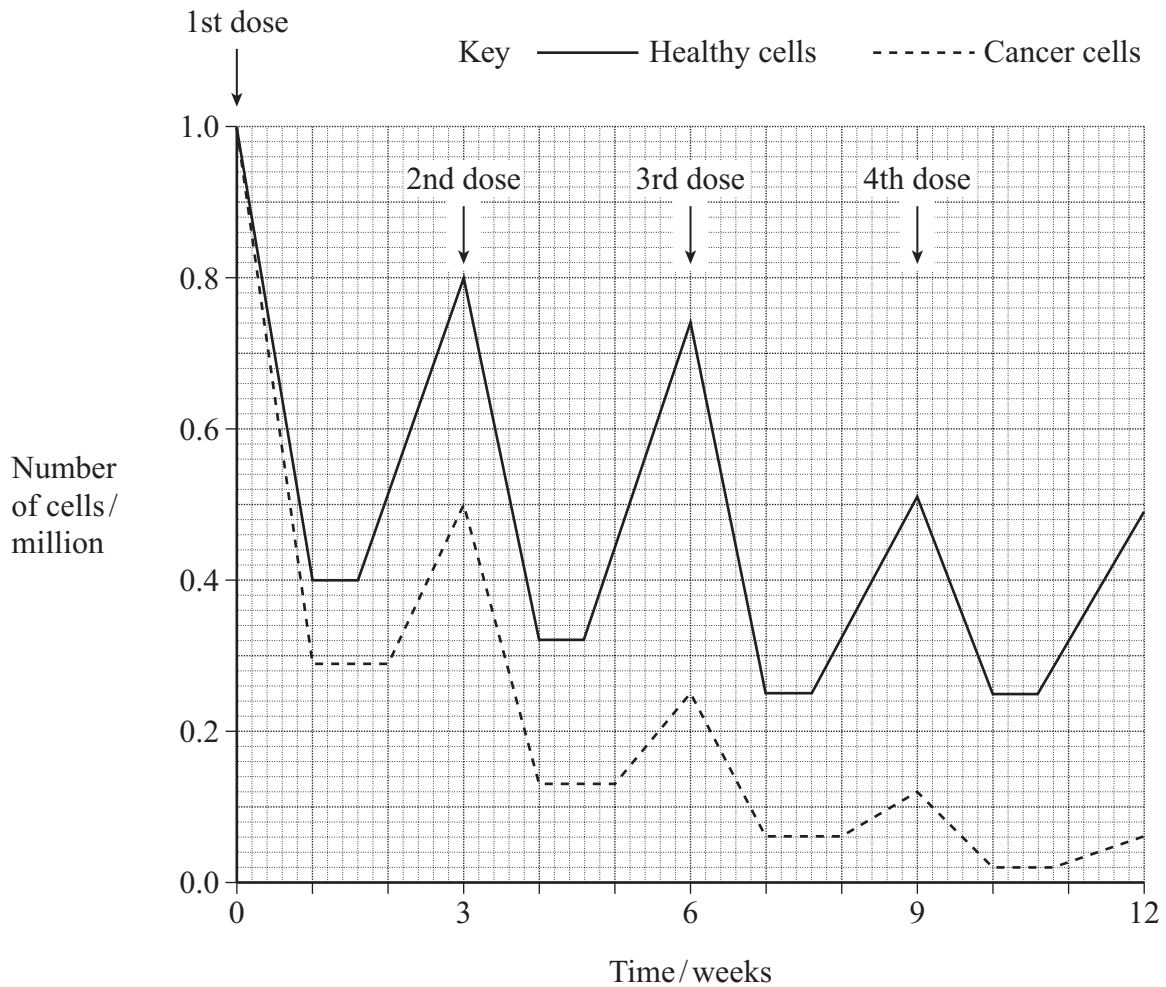
- (b) Name the phase during which DNA replication occurs.

.....

(1 mark)

**Question 2 continues on the next page**

- (c) Bone marrow cells divide rapidly. As a result of a mutation during DNA replication, a bone marrow cell may become a cancer cell and start to divide in an uncontrolled way. A chemotherapy drug that kills cells when they are dividing was given to a cancer patient. It was given once every three weeks, starting at time 0. The graph shows the changes in the number of healthy bone marrow cells and cancer cells during twelve weeks of treatment.



- (i) Using the graph calculate the number of cancer cells present at week 12 as a percentage of the original number of cancer cells. Show your working.

Answer ..... %  
(2 marks)

- (ii) Suggest **one** reason for the lower number of cancer cells compared to healthy cells at the end of the first week.

.....  
.....  
(1 mark)

- (iii) Describe **two** differences in the effect of the drug on the cancer cells, compared with healthy cells in the following weeks.

1 .....  
.....  
2 .....  
.....  
(2 marks)

8
---

**Turn over for the next question**

Answer **all** questions in the spaces provided.

24 1 (a) The photographs show two stages in mitosis.

**A**



**B**



Name stages **A** and **B**. Describe what is happening to the chromosomes in each stage.

(i) Stage **A** .....

.....  
.....  
.....

(2 marks)

(ii) Stage **B** .....

.....  
.....  
.....

(2 marks)

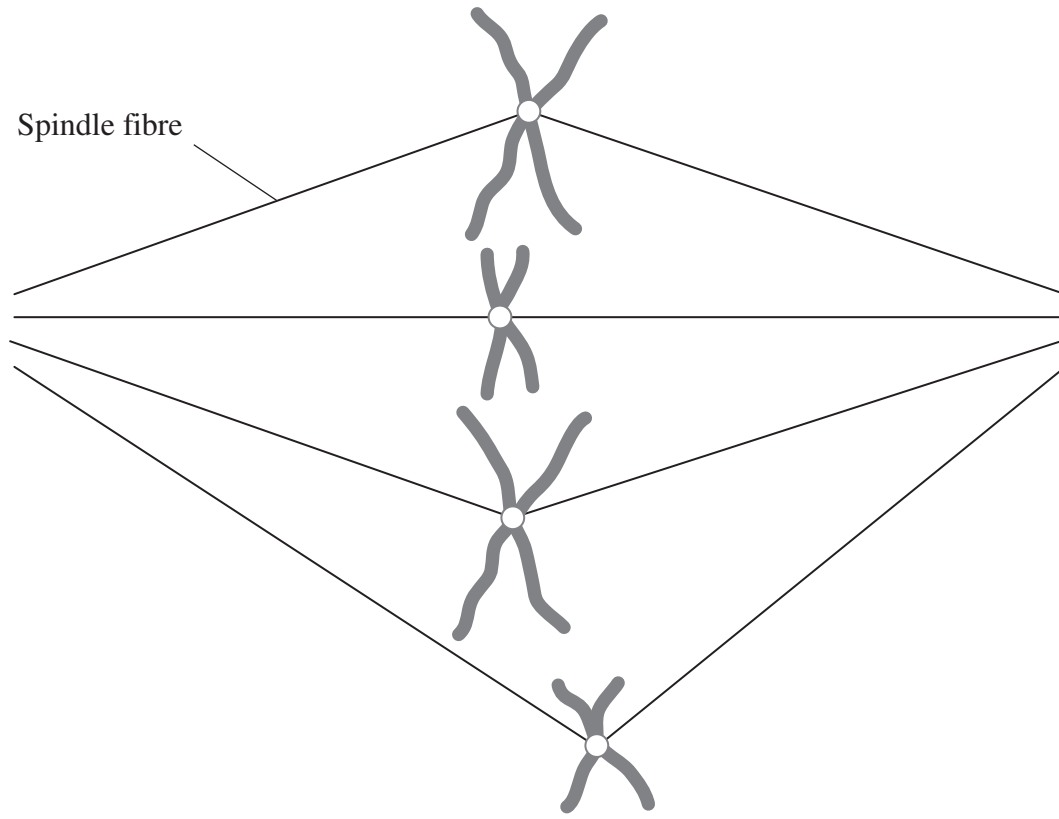
(b) A clone of genetically identical animals can be obtained from one embryo.  
Explain how.

.....  
.....  
.....  
.....

(2 marks)

46

25 5 (a) The diagram shows a stage of mitosis.



Describe what happens in the next stage of mitosis.

.....

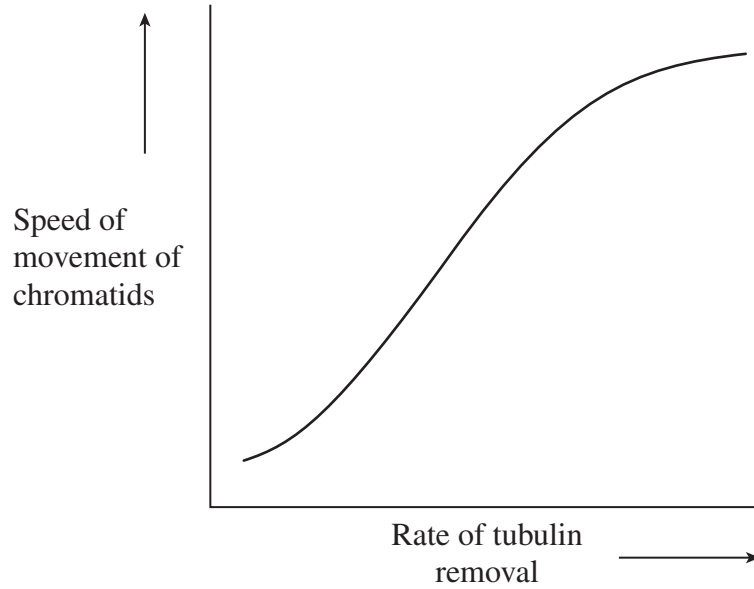
.....

.....

.....

(2 marks)

(b) Spindle fibres are polymers made from tubulin monomers. The removal of tubulin monomers causes spindle fibres to shorten. Scientists investigated the effect of the rate of tubulin removal on the speed of movement of chromatids during mitosis. The results are shown on the graph.



What do these results suggest about the role of spindle fibres in the movement of chromatids during mitosis?

.....

.....

.....

.....

(2 marks)

4