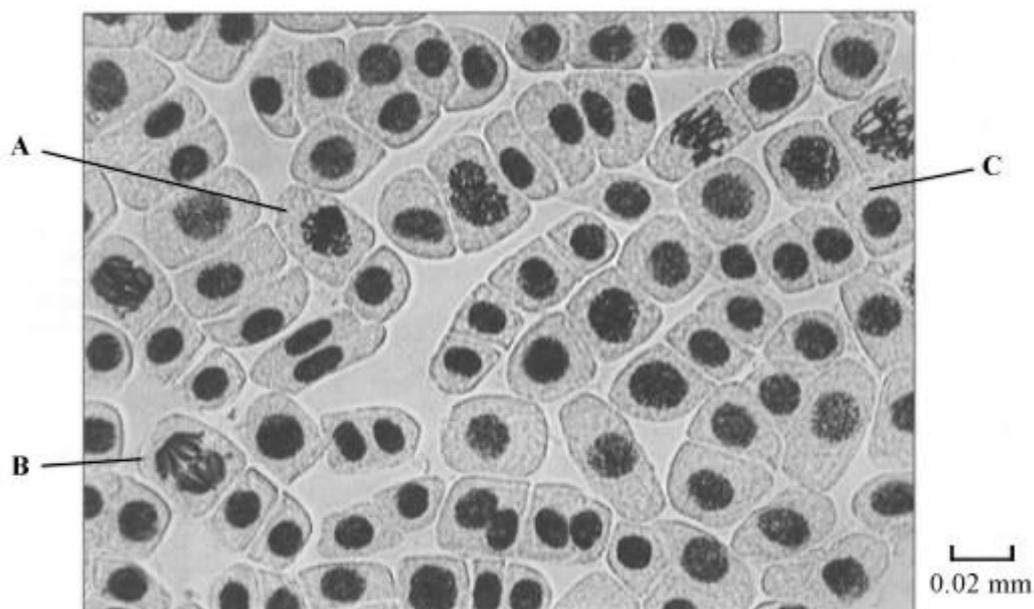


2.2 THE CELL CYCLE, INCLUDING MITOSIS 1 - QUESTIONS

Q1. 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)

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

_____ (1)

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

1. _____

2. _____
_____ (2)

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

_____ (1)

(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

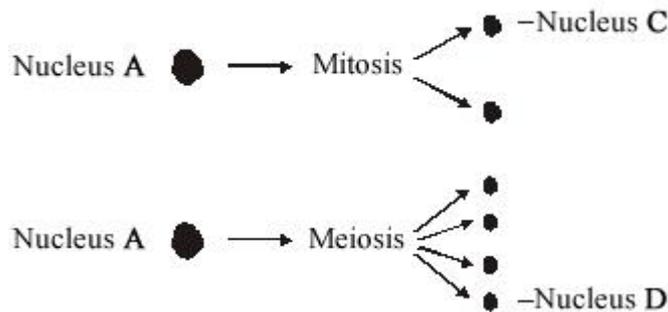
One complete cell cycle takes 24 hours. The number of cells at each stage is proportional to the time spent at that stage. Calculate the length of time spent in metaphase. Show your working.

Answer _____ hours

(2)

(Total 7 marks)

Q2. (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
A	8	600
B	8	600

C		
D		

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

(2)

(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.

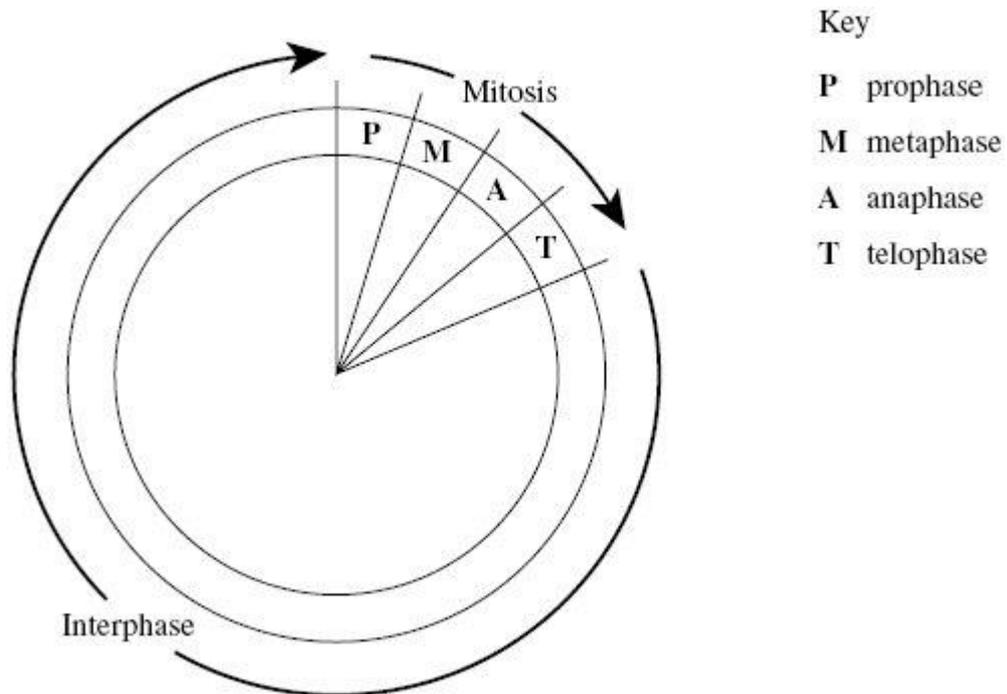
(1)

(ii) Explain why a stain was used.

(1)

(Total 4 marks)

Q3. The diagram shows a cell cycle.



(a) The table shows the number of chromosomes and the mass of DNA in different nuclei.

All the nuclei come from the same animal. Complete this table.

Nucleus	Number of chromosomes	Mass of DNA / arbitrary units
At prophase of mitosis	26	60

At telophase of mitosis		
From a sperm cell		

(4)

- (b) If the DNA of the cell is damaged, a protein called p53 stops the cell cycle. Mutation in the gene for p53 could cause cancer to develop. Explain how.

(3)

- (c) Drugs are used to treat cancer. At what phase in the cell cycle would each of the following drugs act?

- (i) A drug that prevents DNA replication

(1)

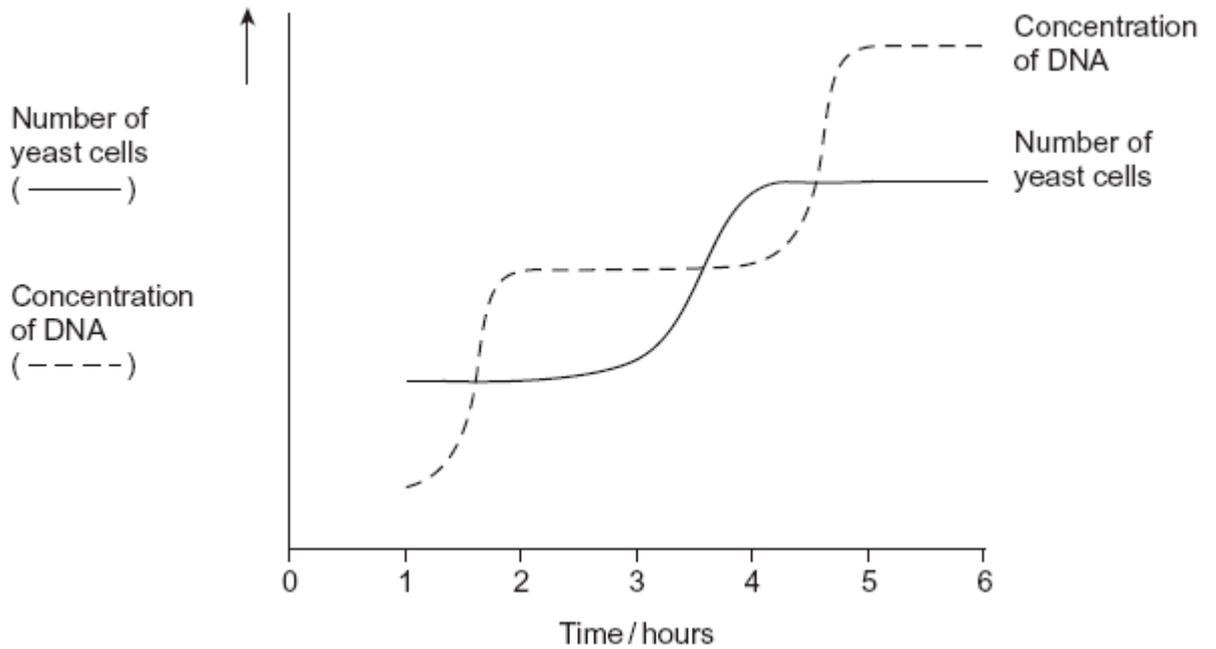
- (ii) A drug that prevents spindle fibres shortening

(1)

(Total 9 marks)

Q4. Yeast is a single-celled eukaryotic organism. When yeast cells are grown, each cell forms a bud. This bud grows into a new cell. This allows yeast to multiply because the parent cell is still alive and the new cell has been formed.

Scientists grew yeast cells in a culture. They counted the number of cells present and measured the total concentration of DNA in the culture over a period of 6 hours. Their results are shown in the graph.



(a) Use your knowledge of the cell cycle to explain the shape of the curve for the number of yeast cells

(i) between 1 and 2 hours

(1)

(ii) between 3 and 4 hours.

(1)

(b) Use the curve for the concentration of DNA to find the length of a cell cycle in these yeast cells. Explain how you arrived at your answer.

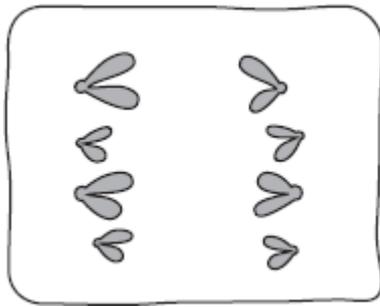
Length of cell cycle _____

Explanation _____

(3)

(Total 5 marks)

Q5. (a) The diagram shows a stage of mitosis in an animal cell.



(i) Name this stage.

(1)

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

(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.

(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)

(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)

(Total 6 marks)

Q6. A student investigated mitosis in the tissue from an onion root tip.

(a) The student prepared a temporary mount of the onion tissue on a glass slide. She covered the tissue with a cover slip. She was then given the following instruction.

“Push down hard on the cover slip, but do not push the cover slip sideways.”

Explain why she was given this instruction.

(2)

The image below shows one cell the student saw in the onion tissue.



© Ed Reschke/
Oxford Scientific/Getty Images

- (b) The student concluded that the cell in the image above was in the anaphase stage of mitosis.
Was she correct? Give **two** reasons for your answer.

1. _____

2. _____

(2)

- (c) The student counted the number of cells she observed in each stage of mitosis. Of the 200 cells she counted, only six were in anaphase.

One cell cycle of onion root tissue takes 16 hours. Calculate how many minutes these cells spend in anaphase.

Show your working.

Answer = _____ minutes

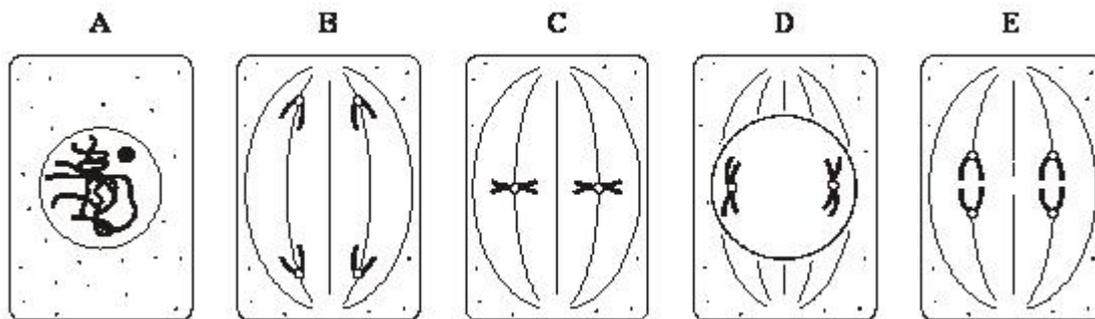
(2)

(Total 6 marks)

- Q7.** (a) In which phase of the cell cycle does DNA replication take place?

_____ (1)

(b) The diagrams show five stages of mitosis.



List the stages **A** to **E** in the correct sequence, beginning with the earliest stage.

_____ (1)

(c) Describe the role of the spindle during mitosis.

 _____ (2)

(d) Meiosis also occurs during the life cycle of organisms. What is the importance of meiosis?

 _____ (2)
(Total 6 marks)

Q8. 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)

(ii) a stain was used;

(1)

(iii) the root tip was firmly squashed.

(1)

(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)

(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. _____

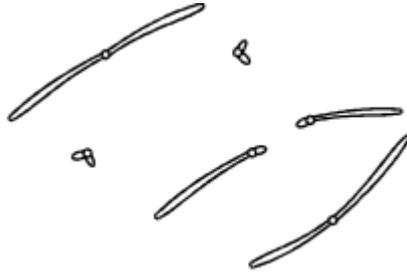
(2)

(Total 7 marks)

Q9. (a) Give **one** process which occurs in the nucleus of a cell during interphase which is necessary before cell division can take place.

(1)

- (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)

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

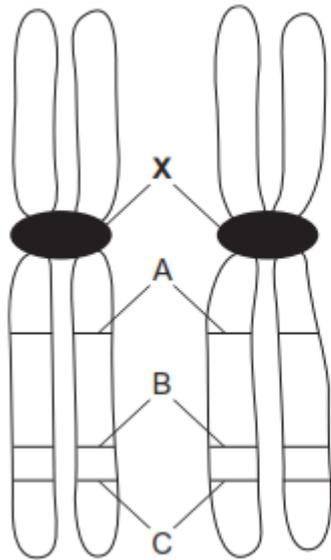
(2)

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

(1)

(Total 6 marks)

Q10. The diagram shows two chromosomes in a cell undergoing mitosis.



A – Gene for feature A
 B – Gene for feature B
 C – Gene for feature C

(a) Name X.

_____ (1)

(b) These are homologous chromosomes. Give **two** pieces of evidence from the diagram that support this.

1. _____

2. _____

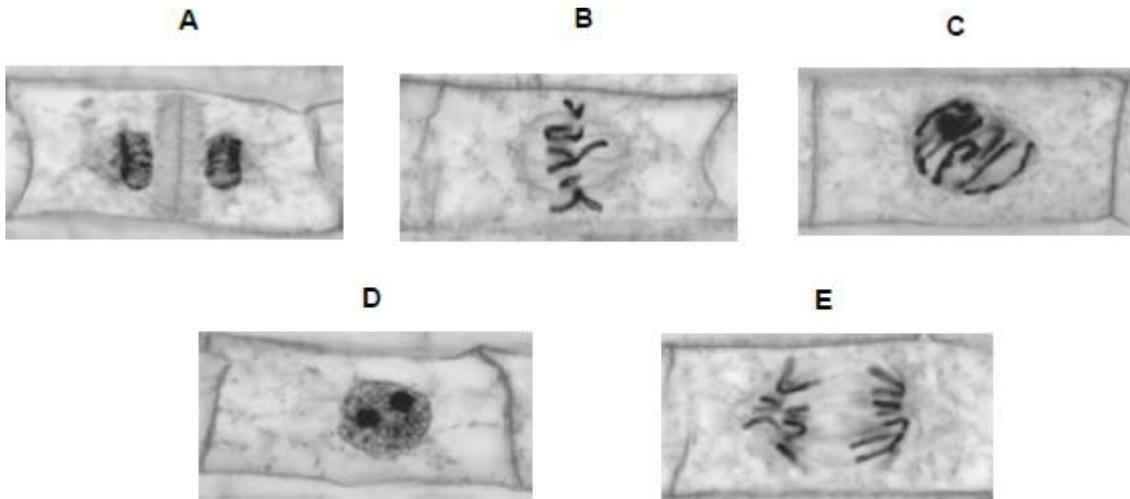
_____ (2)

(c) What will happen to these chromosomes in anaphase?

_____ (2)

(2)
 (Total 5 marks)

Q11. The figure below shows some cells from an onion root tip at different stages of the cell cycle.



© Ed Reschke/Oxford Scientific/Getty Images

(a) Place stages **A** to **E** in the correct order. Start with stage **D**.

D

(1)

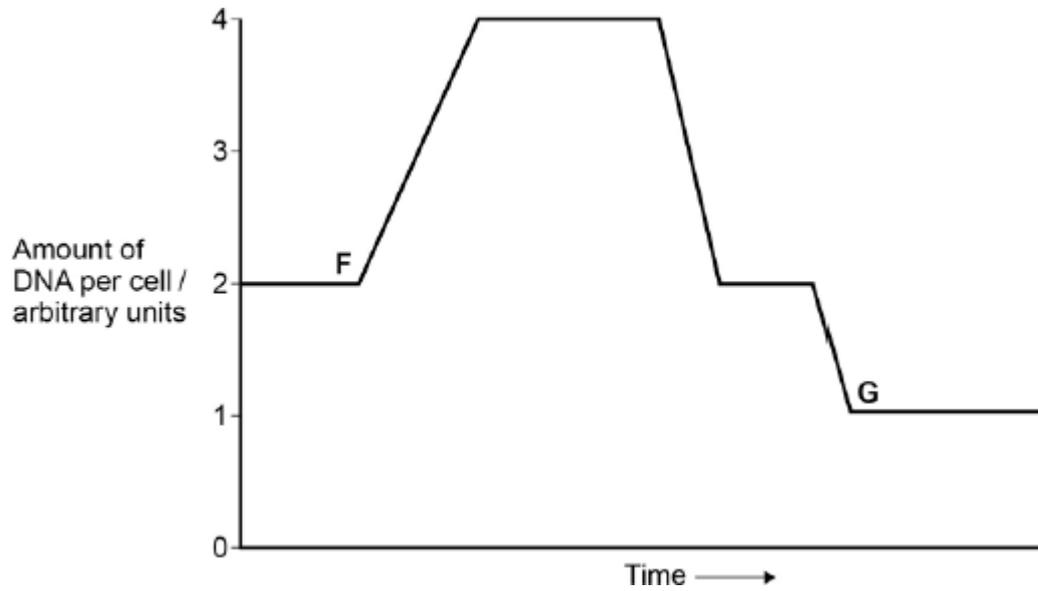
To obtain these images, the onion root tip was cut off, stained and put on a microscope slide. A cover slip was placed on top. The root tip was then firmly squashed and viewed under an optical microscope.

(b) Complete the table below to give **one** reason why each of these steps was necessary.

Step	Reason
Taking cells from the root tip	
Firmly squashing the root tip	

(2)

The figure below shows how the amount of DNA per cell changed during interphase and meiosis in an animal.



- (c) Explain how the behaviour of chromosomes causes these changes in the amount of DNA per cell between **F** and **G**.

(Extra space)

(3)

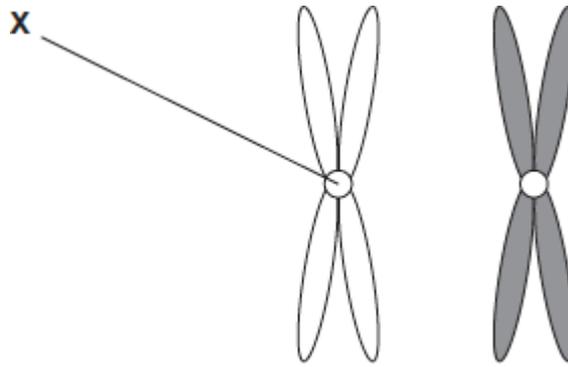
- (d) What would happen to the amount of DNA per cell at fertilisation of cell **G**?

(1)

(Total 7 marks)

Q12. (a) **Figure 1** shows one pair of homologous chromosomes.

Figure 1



(i) Name **X**.

(1)

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

(2)

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

(1)

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

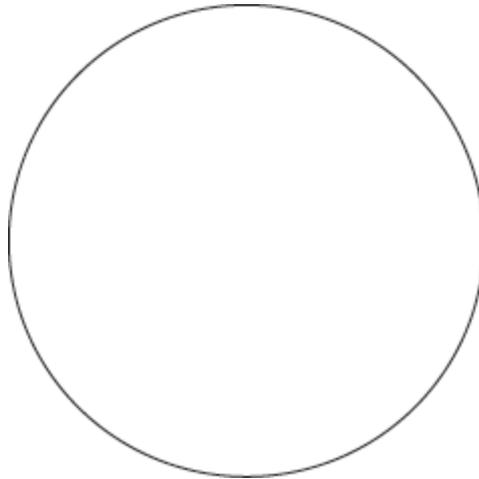
Figure 2



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

(1)

- (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)

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

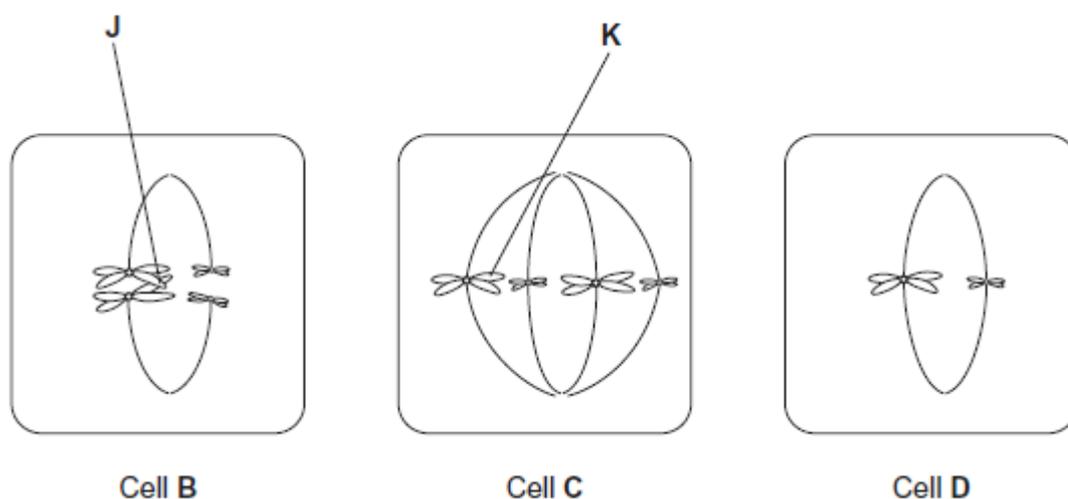
(1)

(Total 8 marks)

Q13. **Figure 1** shows three cells, **B**, **C** and **D**, from tissues in the same organism. Each cell is in a

stage of either mitosis or meiosis.

Figure 1



(a) Complete the table with a tick if the cell shows the feature.

	Cell B	Cell C	Cell D
homologous chromosomes are present			
a stage of mitosis			

(2)

(b) Describe and explain the appearance of chromosome **K** in cell **C**.

(2)

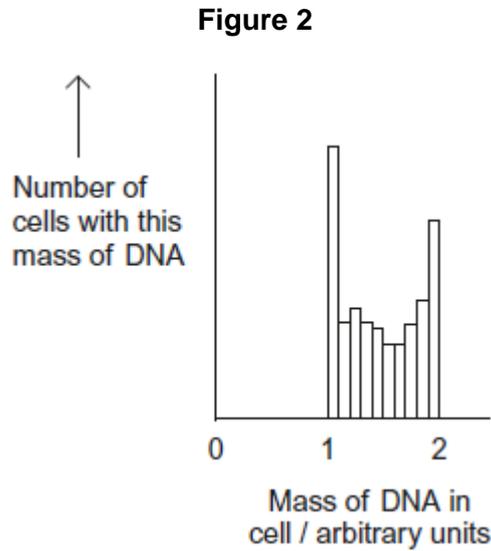
(c) Explain what is happening at point **J** in cell **B**.

(2)

(d) Use information from all three cells in **Figure 1** to explain how the number of chromosomes in cell **D** was produced.

(1)

- (e) **Figure 2** shows the mass of DNA present in cells of a population of healthy cells where mitosis is occurring.

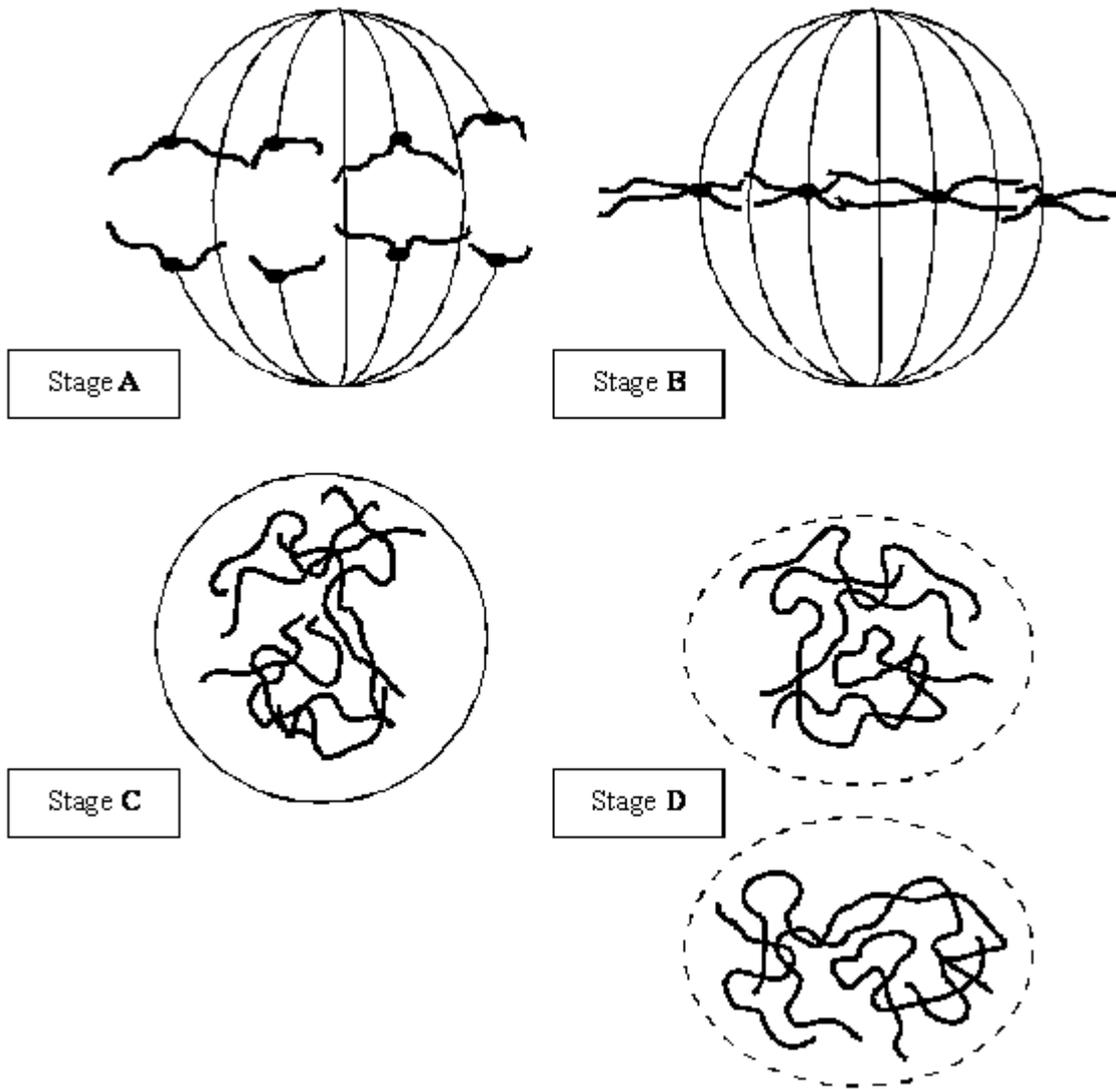


Explain why some cells contain a mass of DNA between 1 and 2 arbitrary units.

(1)

(Total 8 marks)

Q14. The diagrams show four stages of mitosis.



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

(1)

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

C _____

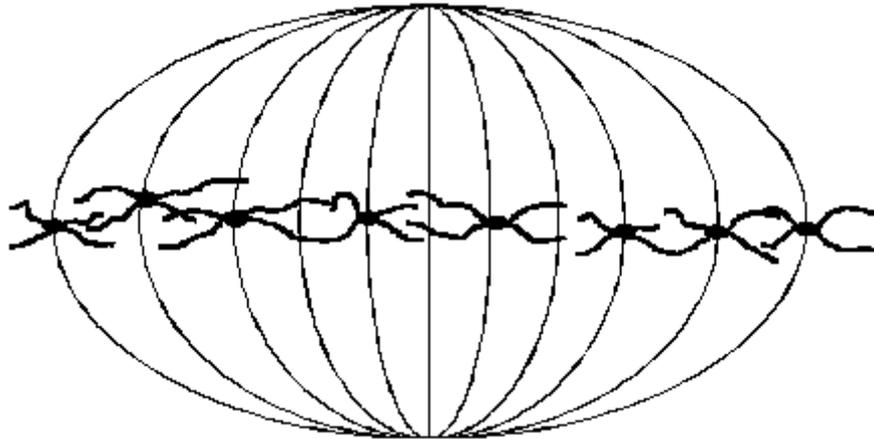
(1)

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

(2)

(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?

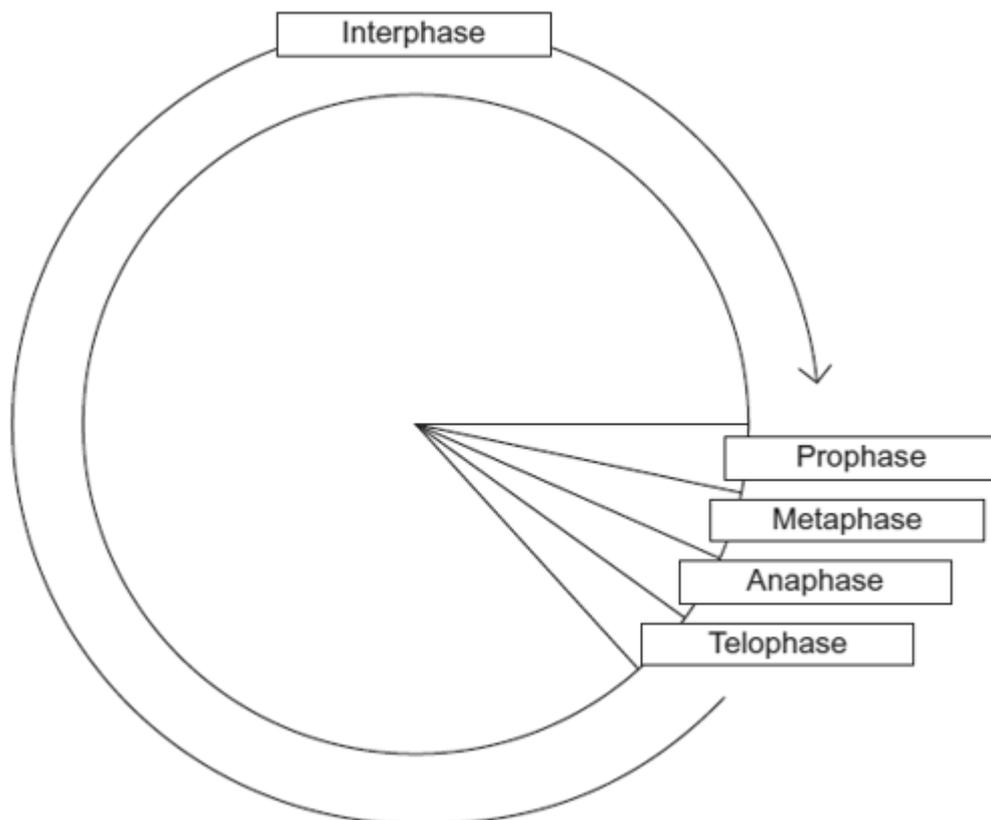
(1)

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

(1)

(Total 6 marks)

Q15. The diagram shows a cell cycle.



(a) In prophase of mitosis, the chromosomes become visible. Describe what happens in

(i) metaphase

(2)

(ii) anaphase.

(2)

(b) (i) Cells lining the human intestine complete the cell cycle in a short time. Explain the advantage of these cells completing the cell cycle in a short time.

(1)

(ii) The time required for a cell to complete the cell cycle was 4 hours 18 minutes.

Calculate the time required in minutes for this cell to multiply to produce eight cells.

Show your working.

Answer _____

(2)

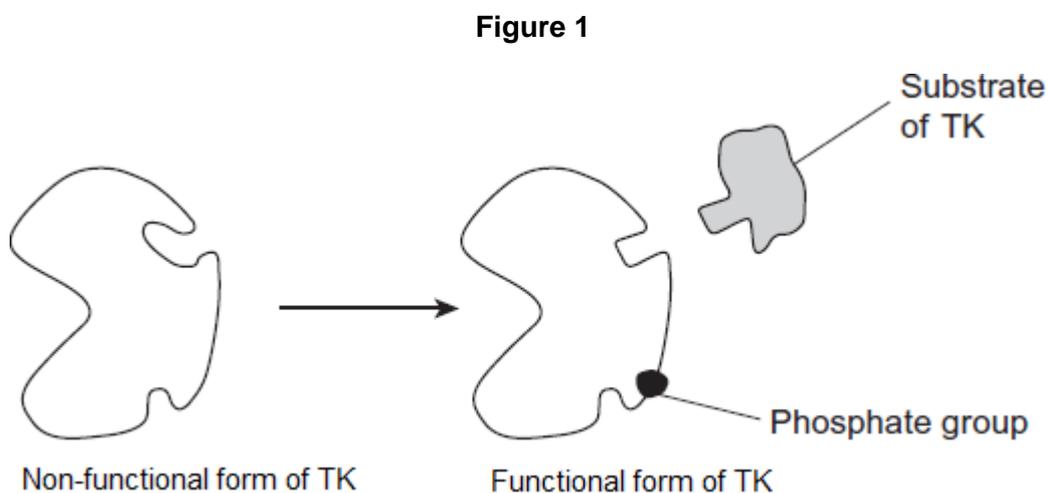
(c) Mikanolide is a drug that inhibits the enzyme DNA polymerase. Explain why this

drug may be effective against some types of cancer.

(2)
(Total 9 marks)

Q16. The enzyme tyrosine kinase (TK) is found in human cells. TK can exist in a non-functional and a functional form. The functional form of TK is only produced when a phosphate group is added to TK.

This is shown in **Figure 1**.



- (a) Addition of a phosphate group to the non-functional form of TK leads to production of the functional form of TK.

Explain how.

(2)

- (b) The binding of the functional form of TK to its substrate leads to cell division. Chronic myeloid leukaemia is a cancer caused by a faulty form of TK. Cancer involves uncontrolled cell division.

Figure 2 shows the faulty form of TK.

Figure 2



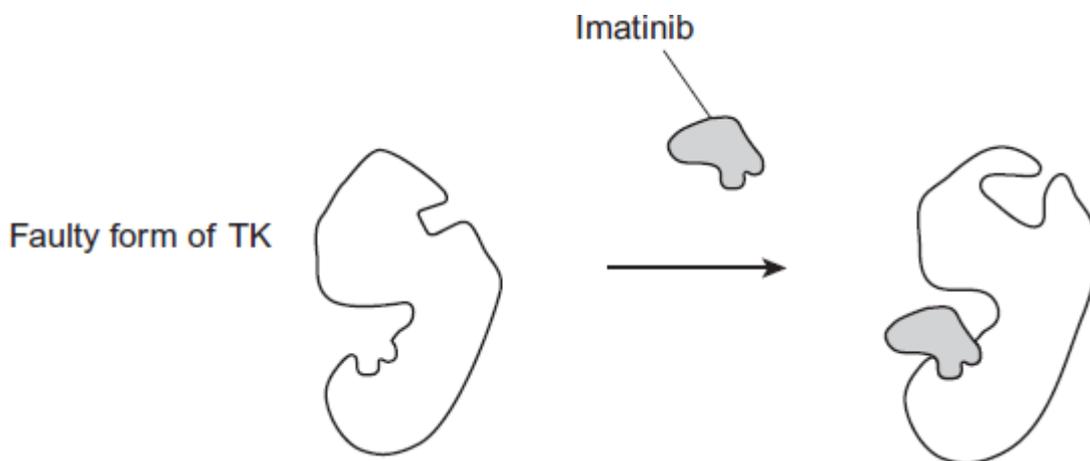
Faulty form of TK

Suggest how faulty TK leads to chronic myeloid leukaemia.

(2)

- (c) Imatinib is a drug used to treat chronic myeloid leukaemia. **Figure 3** shows how imatinib inhibits faulty TK.

Figure 3



Using all of the information, describe how imatinib stops the development of chronic myeloid leukaemia.

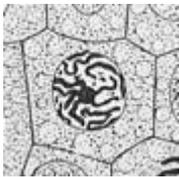
(2)
(Total 6 marks)

Q17. (a) Mitosis is important in the life of an organism. Give **two** reasons why.

(2)

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

Images by Edmund Beecher Wilson [Public domain], via Wikimedia Commons

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

(1)

(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)

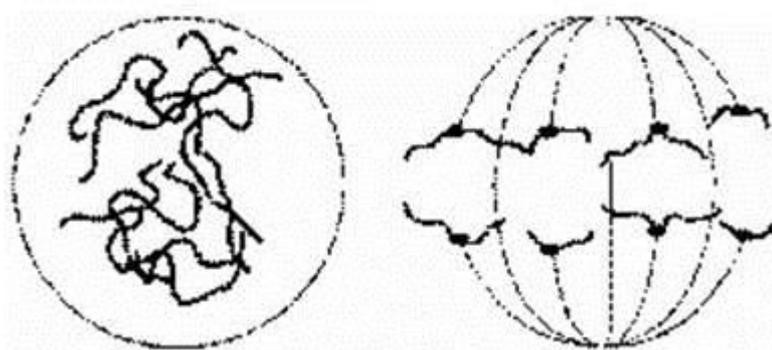
- (c) In this tissue one complete cell cycle took 20 hours.
Using information from the table, calculate the mean time for these cells to complete mitosis. Show your working.

Answer _____

(2)

(Total 9 marks)

- Q18.** (a) The photographs show two stages in mitosis of a plant cell.



A

B

Name stages **A** and **B**. In each case describe what is happening to the chromosomes.

- (i) Stage **A** _____

(2)

- (ii) Stage **B** _____

(2)

(b) Describe **two** events during interphase which prepare a cell for mitosis.

1. _____

2. _____

(2)

(Total 6 marks)

Q19. Division of the nucleus by meiosis produces haploid cells from a diploid cell. Nuclei produced by mitosis have the same number of chromosomes as the parent nucleus.

(a) What is the biological importance of reducing the chromosome number when the cell divides by meiosis?

(2)

(b) The table gives one difference between meiosis and mitosis. Complete the table by giving **three** further differences.

	Meiosis	Mitosis
1	Reduces the chromosome number	Maintains the same chromosome number as in the parent nucleus
2		
3		
4		

(3)

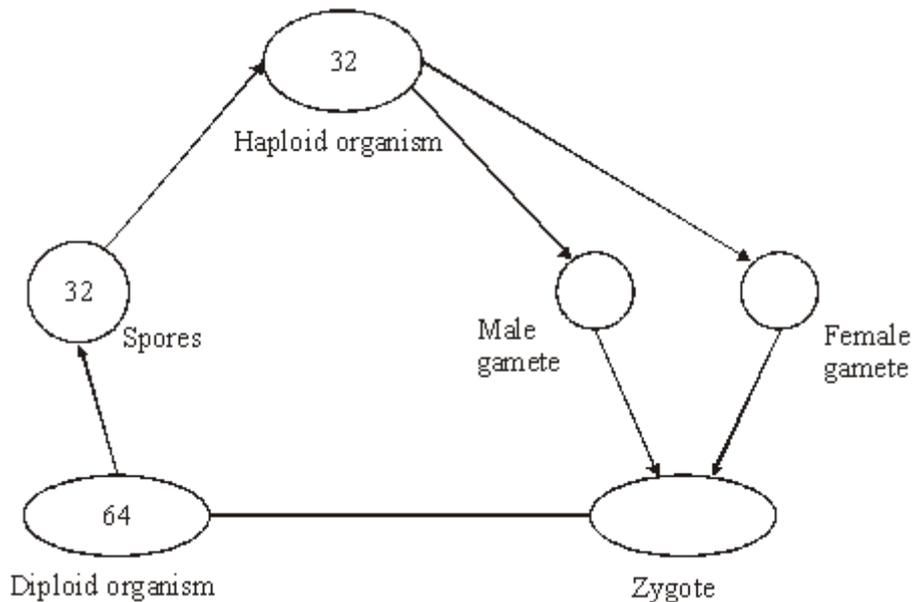
(Total 5 marks)

Q20. (a) Complete the table to describe some of the events during the cell cycle.

Stage of cell cycle	Main event which takes place
Metaphase	
	Chromosomes coil and shorten
	Daughter chromosomes move to poles of the cell
S-phase	
	Nuclear envelope re-forms

(5)

(b) The diagram shows the life cycle of an organism. The numbers show how many chromosomes are present in one cell at each stage of the life cycle.



(i) Name the type of cell division that must be involved in producing the spores.

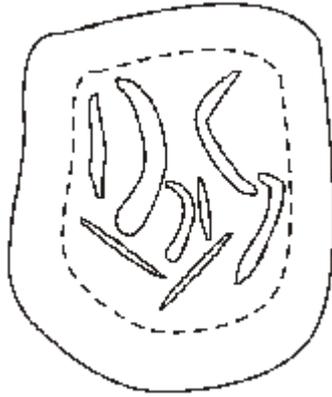
(1)

(ii) How many chromosomes are there in a male gamete from this organism?

(1)

(Total 7 marks)

Q21. The diagram represents a cell from a fruit fly in which the diploid number is eight.



- (a) Draw a diagram to show
- (i) this cell during anaphase of mitosis;

(2)

- (ii) the chromosomes in a gamete produced from this cell by meiosis.

(2)

- (b) Explain why meiosis is important in sexual reproduction, apart from producing gametes that are genetically different.

(2)

(Total 6 marks)

- Q22.** (a) Some tumours are benign and some are malignant.

- (i) Give **one** way in which a benign tumour differs from a malignant tumour.

(1)

(ii) Describe **two** ways in which both types of tumour may cause harm to the body.

1. _____

2. _____

(2)

(b) (i) Explain the link between sunbathing and skin cancer.

(2)

(ii) Suggest why fair-skinned people are at a greater risk of skin cancer than dark-skinned people when sunbathing.

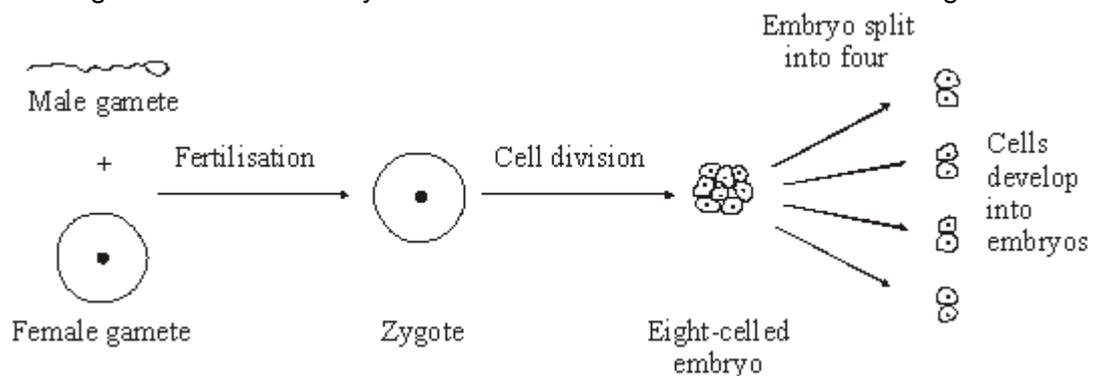
(1)

(iii) Suggest why people with a family history of cancer are at a greater risk of cancer than those with no family history of cancer.

(1)

(Total 7 marks)

Q23. An egg cell from a cow was fertilised in a laboratory and allowed to develop into an eight-celled embryo. This was split into four parts, each of which developed into a new embryo. This is shown in the diagram. The new embryos were later transferred into different surrogate cows.



(a) Explain why the new embryos produced are a clone.

(2)

(b) If embryos with more than eight cells are split up, the separated cells fail to develop into new embryos. Suggest why.

(1)

(c) Give **two** advantages to a farmer of using embryos produced by this procedure.

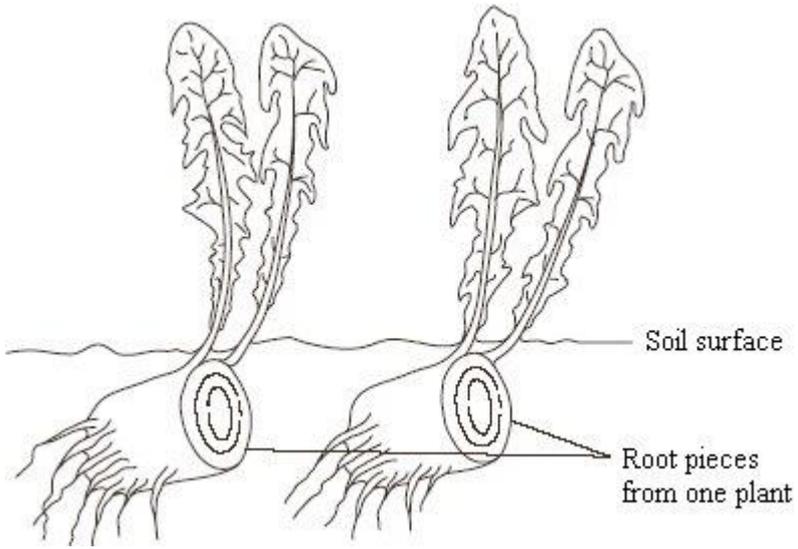
Advantage 1 _____

Advantage 2 _____

(2)

(Total 5 marks)

Q24. It is difficult to get rid of dandelions from a garden because small pieces of the root are able to grow into new plants if left behind in the soil. This is shown in the drawing.



(a) Explain why the plants produced form a clone.

(2)

(b) Suggest **one** reason why the plants in a clone may not be identical in appearance.

(1)

(c) Most plants produce seeds after fertilisation in sexual reproduction. However, dandelions produce small, windblown seeds without fertilisation taking place. Suggest **two** advantages to the dandelion of being able to reproduce from these seeds, as well as from pieces of root.

Advantage 1 _____

Advantage 2 _____

(2)

(Total 5 marks)

Q25. (a) Boxes **A** to **E** show some of the events of the cell cycle.

A Chromatids separate

B Nuclear envelopes disappear

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)

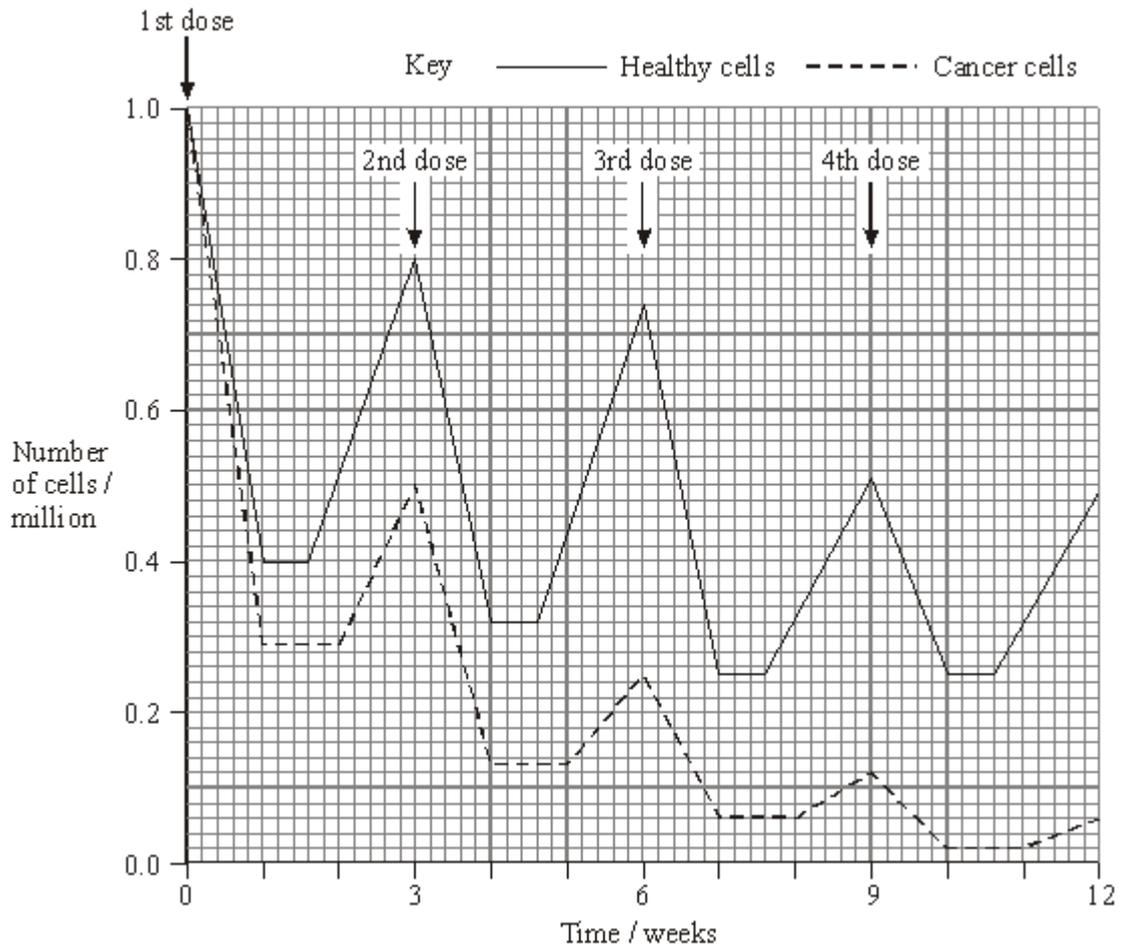
(ii) Name the stage described in box **E**.

(1)

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

(1)

(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)

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

(1)

- (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)

(Total 8 marks)

Q26. (a) The following statements describe stages of mitosis.

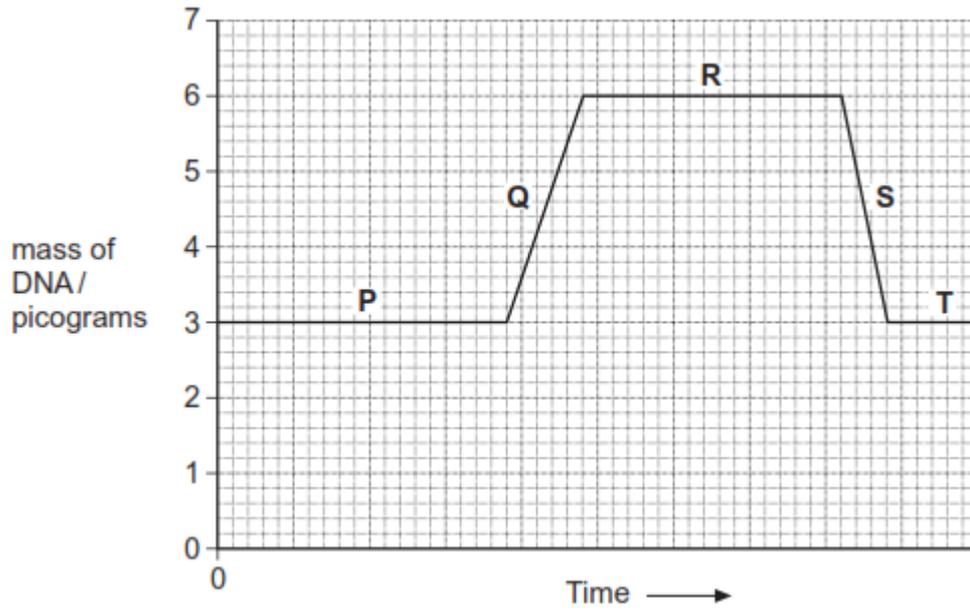
- A** chromosomes align at the centre of the cell attached to spindle fibres
- B** chromatids are in groups at the poles
- C** chromosomes become visible
- D** chromatids move towards the poles

Complete the table by entering the appropriate letter.

Stage of mitosis	Letter of description of the stage
Prophase	
Metaphase	
Anaphase	
Telophase	

(3)

- (b) The graph shows changes in the mass of DNA in a cell during one cell cycle. Five stages have been identified on the graph.



(i) Which letter represents the stage when DNA is replicating?

(1)

(ii) Explain the change in the DNA content during stage S.

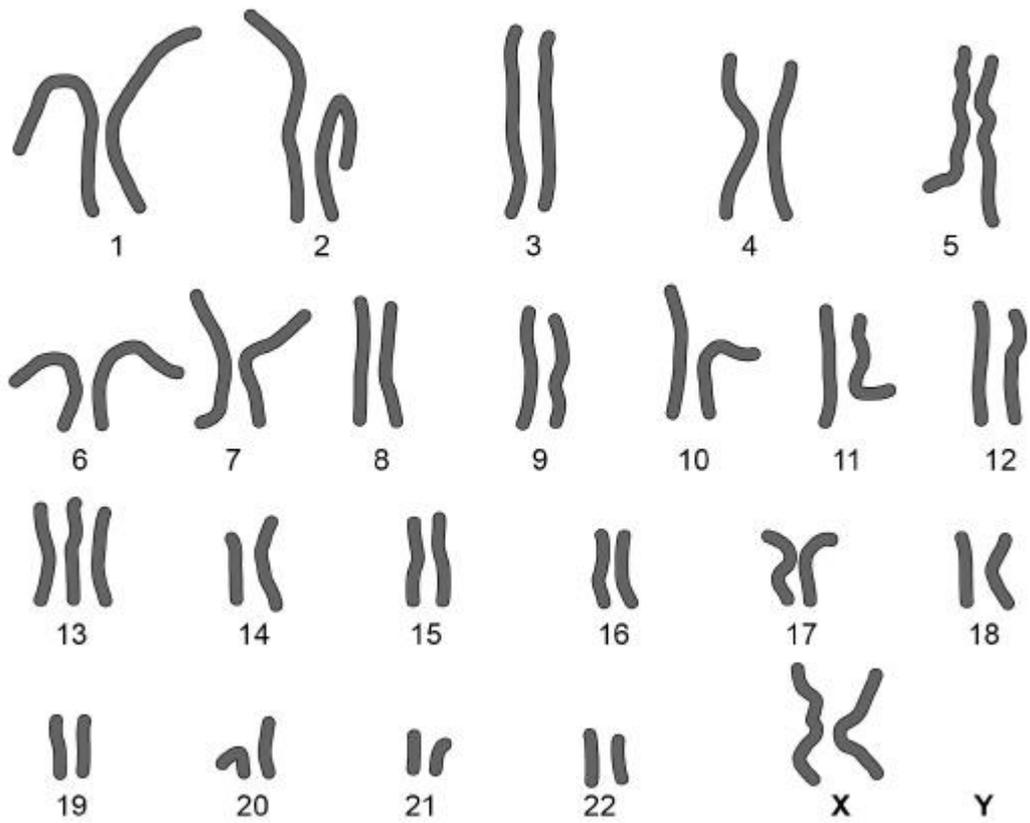
(1)

(Total 5 marks)

Q27. Patau syndrome is a condition caused by a mutation affecting chromosome number. All the cells of the body will have this mutation.

Figure 1 shows the chromosomes from one of the cells of a female who has Patau syndrome.

Figure 1



(a) What is the effect of Patau syndrome on the chromosomes of this female?

(1)

(b) Describe how the change in chromosome number in Patau syndrome was produced.

(2)

(c) Explain why all the cells of the body will have this mutation.

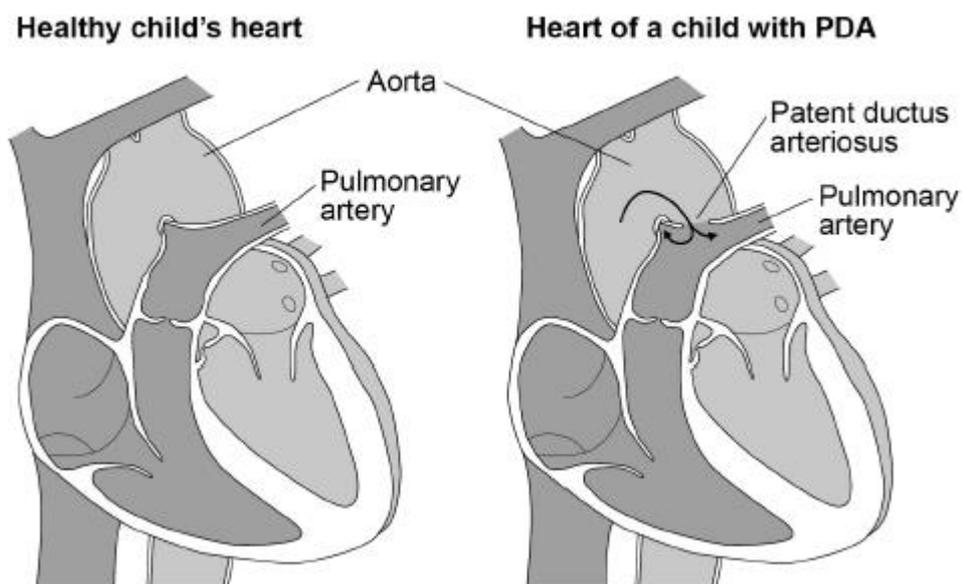
(2)

- (d) Most children born with Patau syndrome die in the first 12 months, often due to defects of circulation of blood.

One of these defects is patent ductus arteriosus (PDA). This can result in some of the blood flowing between the aorta and the pulmonary artery.

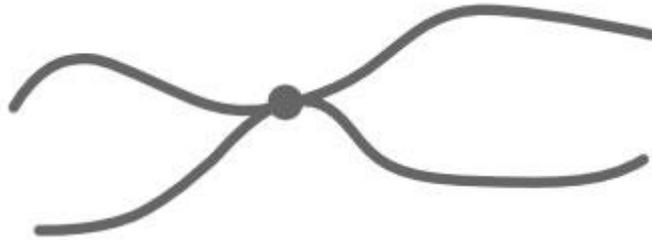
Figure 2 shows a healthy child's heart and the heart of a child with PDA.

Figure 2



Suggest how the flow of some of the blood between the aorta and pulmonary artery could cause children to die in the first 12 months.

Q28. (a) The diagram shows a chromosome at the start of mitosis.



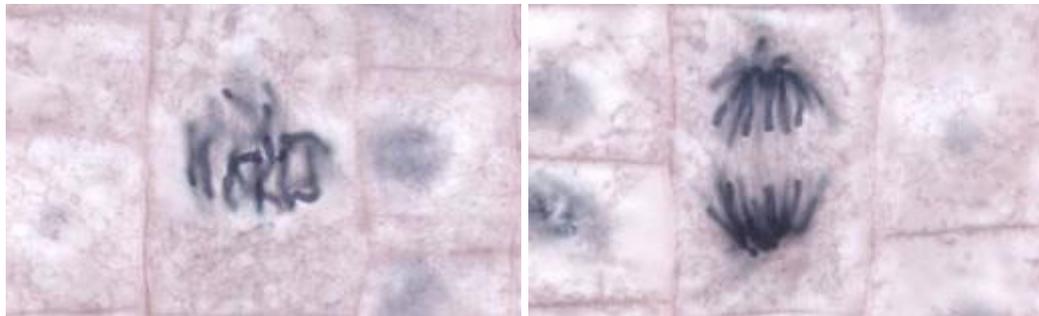
Describe and explain the appearance of the chromosome.

(2)

(b) The photographs show two stages in mitosis.

Stage A

Stage B



By Dr. phil.nat Thomas Geier, Fachgebiet Botanik der Forschungsanstalt Geisenheim.
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Name stages **A** and **B**. Describe what is happening to the chromosomes in each stage.

(i) Stage **A** _____

(2)

(ii) Stage **B** _____

(2)
(Total 6 marks)