AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.2.2 CELL CYCLE AND MITOSIS

SCORE	PERCENTAGE
/357	%

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Q1.

(a) A student prepared a stained squash of cells from the tip of an onion root and observed it using an optical microscope.

During the preparation of the slide, he:

- cut the first 5 mm from the tip of an onion root and placed it on a glass slide
- covered this tip with a drop of stain solution and a cover slip
- warmed the glass slide
- pressed down firmly on the cover slip.

He identified and counted nuclei in different stages of the cell cycle.

Explain why the student:

1. used only the first 5 mm from the tip of an onion root.

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2. pressed down firmly on the cover slip.

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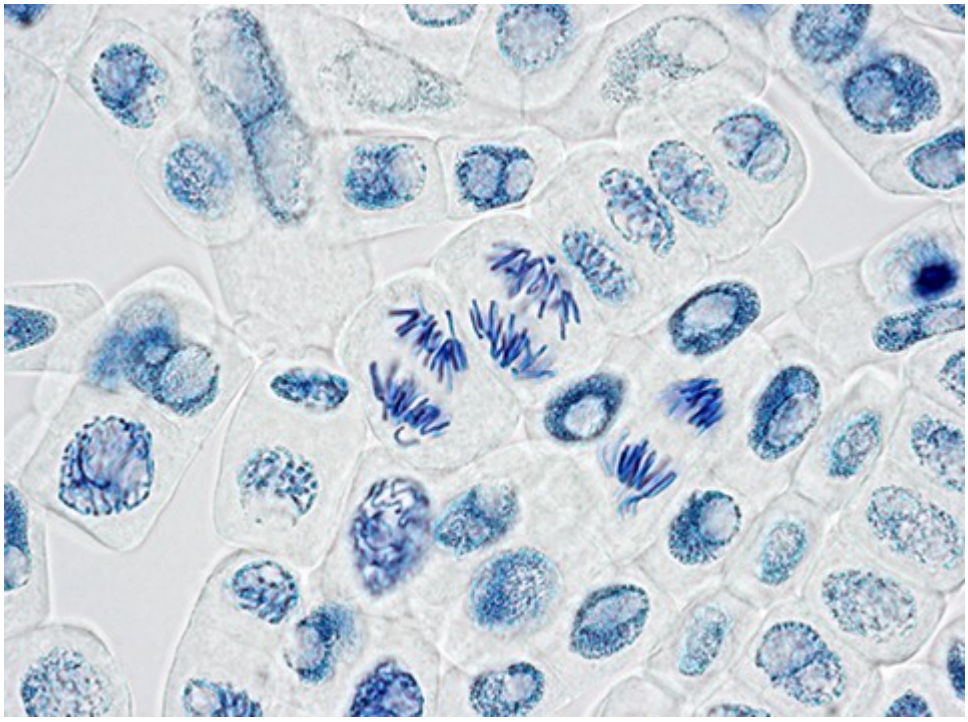
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(2)

Figure 1 shows the cells the student saw in one field of view. He used this field of view to calculate the length of time these onion cells spent in anaphase of mitosis.

Figure 1



(b) Scientists have found the mean length of time spent by onion cells in anaphase of mitosis is 105 minutes. They also found the cell cycle of cells in the onion root shown in **Figure 1** takes 1080 minutes.

32 whole cells are shown in **Figure 1**.

Use this information and **Figure 1** to calculate the length of time the cells of this onion root are in anaphase **and** then calculate the percentage difference between your answer and the mean length of time found by the **scientists**.

Show your working.

Answer = _____ %

(2)

(c) Tick (✓) the name given to the division of cytoplasm during the cell cycle.

A Binary fission ☐

B Cytokinesis ☐

C Phagocytosis ☐

D Segregation ☐

(1)

(d) Describe and explain what the student should have done when counting cells to make sure that the mitotic index he obtained for this root tip was accurate.

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(2)

(e) A scientist treated growing tips of onion roots with a chemical that stops roots growing. After 24 hours, he prepared a stained squash of these root tips.

Figure 2 is a drawing showing the chromosomes in a single cell observed in the squash of one of these root tips in anaphase. This cell was typical of other cells in anaphase in these root tips.

Figure 2



Use all of this information to suggest how the chemical stops the growth of roots.

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(3)

(Total 10 marks)

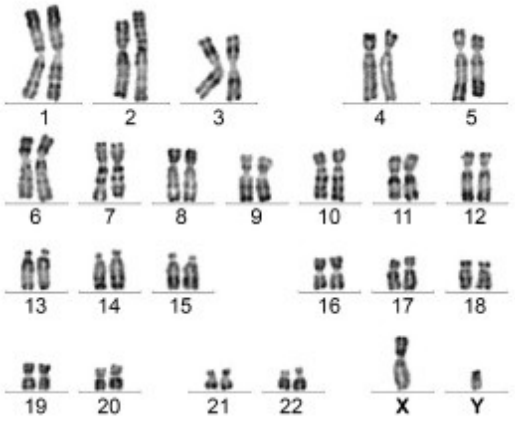
Q2.

Figure 1 shows all the chromosomes present in one human cell during mitosis. A scientist stained and photographed the chromosomes. In **Figure 2**, the scientist has arranged the images of these chromosomes in homologous pairs.

Figure 1



Figure 2



(a) Give **two** pieces of evidence from **Figure 1** that this cell was undergoing mitosis. Explain your answers.

1. _____

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_____

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2. _____

(2)

(b) Tick (✓) **one** box that gives the name of the stage of mitosis shown in **Figure 1**.

A Anaphase ☐

B Interphase ☐

C Prophase ☐

D Telophase ☐

(1)

(c) When preparing the cells for observation the scientist placed them in a solution that had a slightly higher (less negative) water potential than the cytoplasm. This did not cause the cells to burst but moved the chromosomes further apart in order to reduce the overlapping of the chromosomes when observed with an optical microscope.

Suggest how this procedure moved the chromosomes apart.

(2)

(d) The dark stain used on the chromosomes binds more to some areas of the chromosomes than others, giving the chromosomes a striped appearance.

Suggest **one** way the structure of the chromosome could differ along its length to result in the stain binding more in some areas.

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(1)

(e) In **Figure 2** the chromosomes are arranged in homologous pairs.
What is a homologous pair of chromosomes?

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(1)

(f) Give **two** ways in which the arrangement of prokaryotic DNA is different from the arrangement of the human DNA in **Figure 1**.

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(2)

(Total 9 marks)

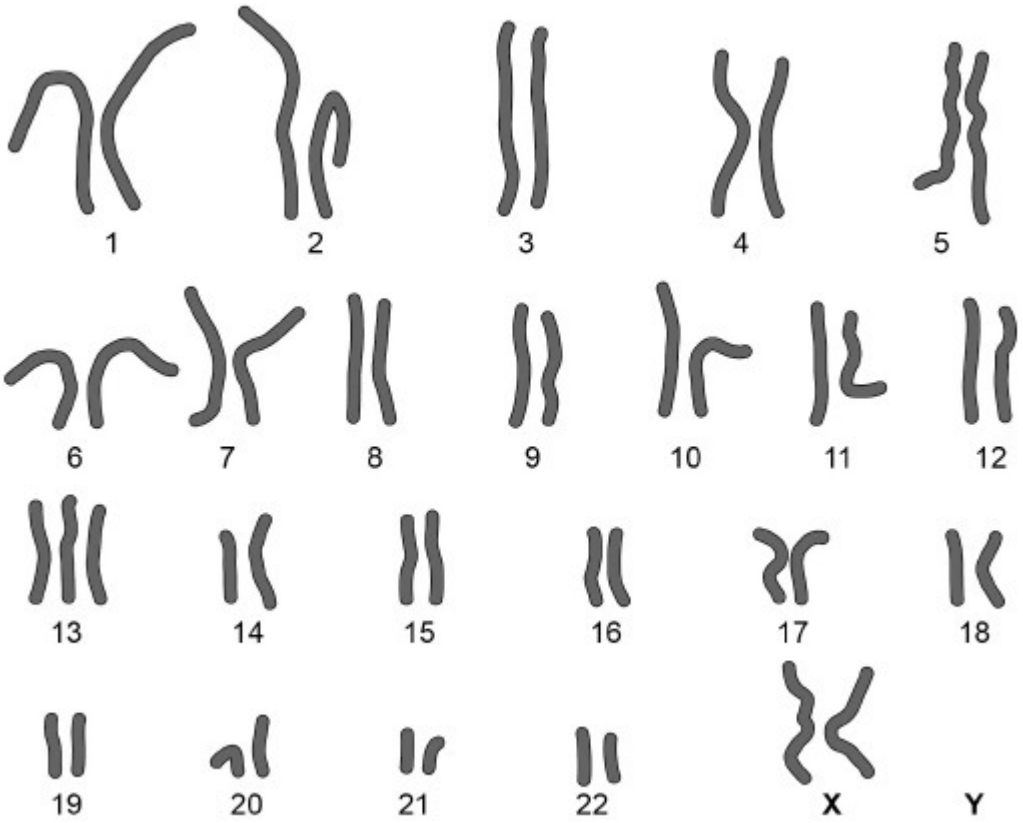
Q3.

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?

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(1)

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

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(2)

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

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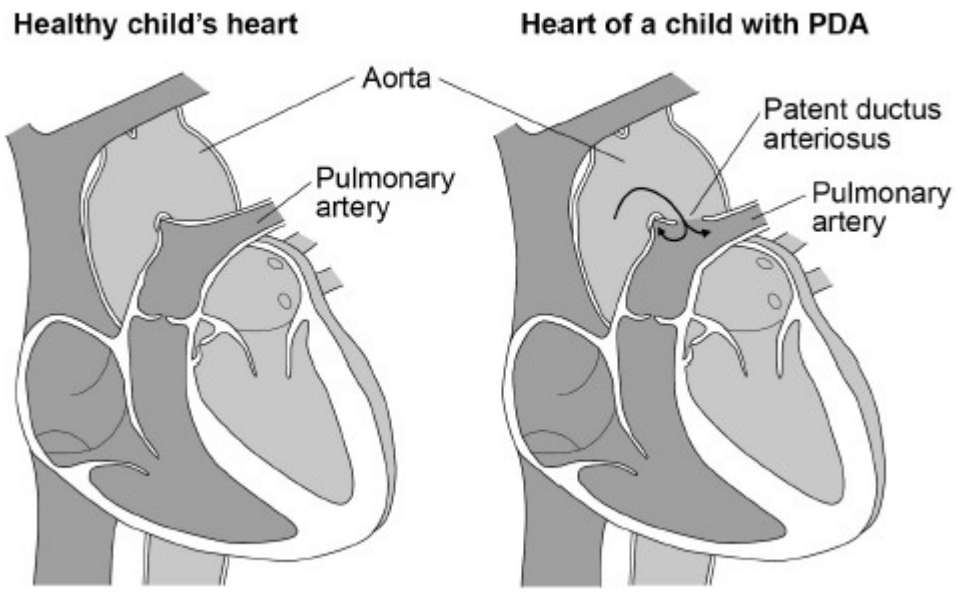
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(2)

(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.

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(3)

(Total 8 marks)

Q4.

(a) Bacteria are often used in industry as a source of enzymes. One reason is because bacteria divide rapidly, producing a large number of them in a short time.

Describe how bacteria divide.

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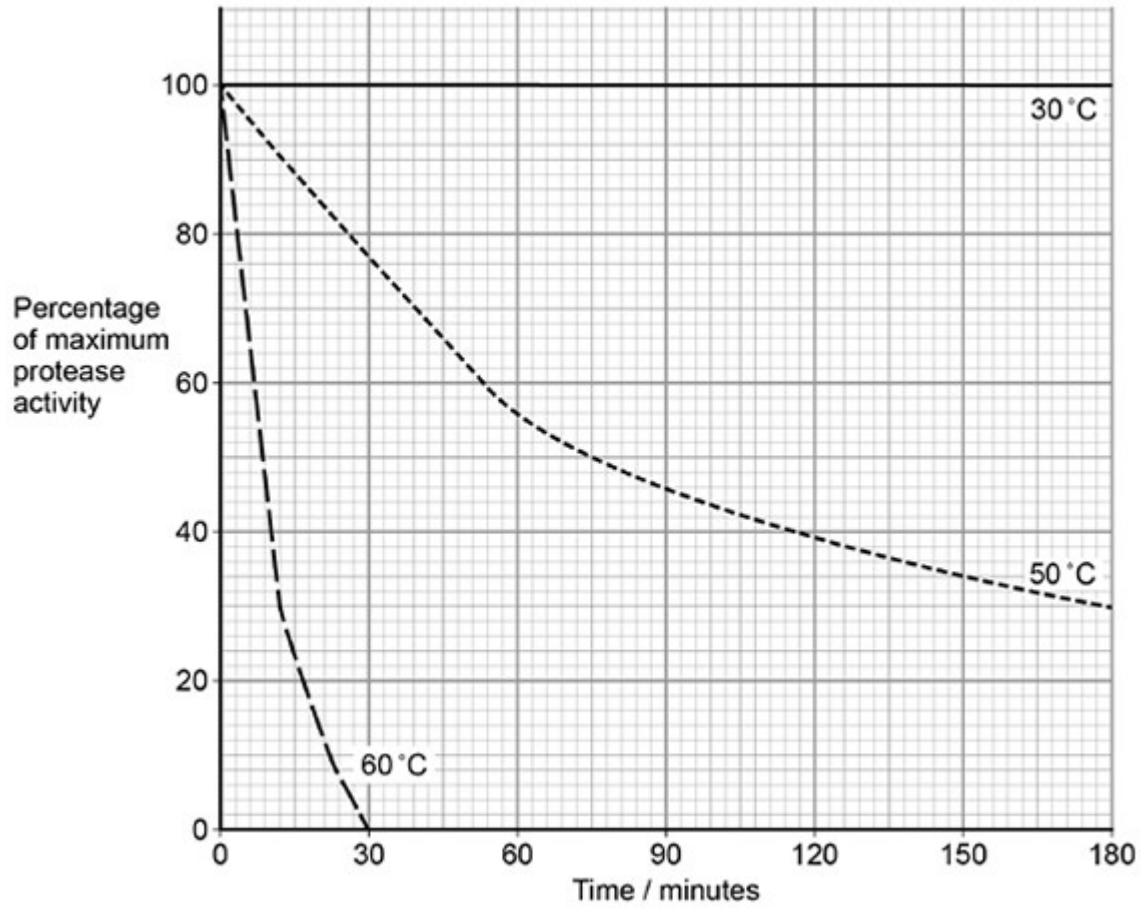
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(2)

(b) Washing powders often contain enzymes from bacteria. These enzymes include proteases that hydrolyse proteins in clothing stains.

The graph shows the effect of temperature on a protease that could be used in washing powder.



Explain the shape of the curves at 50 °C and 60 °C.

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(4)

(c) Some proteases are secreted as extracellular enzymes by bacteria.

Suggest **one** advantage to a bacterium of secreting an extracellular protease in its natural environment.

Explain your answer.

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(2)

(d) Mammals have some cells that produce extracellular proteases. They also have cells with membrane-bound dipeptidases.

Describe the action of these membrane-bound dipeptidases and explain their importance.

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(2)

(Total 10 marks)

Q5.

(a) Name the process by which bacterial cells divide.

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(1)

A microbiologist investigated the ability of different plant oils to kill the bacterium *Listeria monocytogenes*. She cultured the bacteria on agar plates. She obtained the bacteria from a broth culture.

(b) Describe **two** aseptic techniques she would have used when transferring a sample of broth culture on to an agar plate.
Explain why each was important.

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(4)

The microbiologist tested five different plant oils at two different temperatures and determined the minimum concentration of plant oil that killed the *L. monocytogenes*.

The table below shows her results.

Plant oil	**Minimum concentration of plant oil that killed *Listeria monocytogenes* / percentage**	
	4 °C	**35 °C**
Bay	0.10	0.04
Cinnamon	0.08	0.08
Clove	0.05	0.05
Nutmeg	>1.00	0.05
Thyme	0.02	0.03

(c) Which plant oil is least effective at killing *L. monocytogenes* at 35 °C?

_____

(1)

L. monocytogenes is a pathogen of great concern to the food industry, especially in foods stored in refrigeration conditions (4 °C) where, unlike most food-borne pathogens, it is able to multiply. It has been suggested that plant oils, together with refrigeration may help to reduce the growth of *L. monocytogenes*.

(d) What conclusions can be drawn about the effectiveness of using plant oils with refrigeration to reduce food-borne infections caused by *L. monocytogenes*?

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(3)

(e) Plant oils are hydrophobic and can cross the cell-surface membrane of the bacterium. The low temperature of 4 °C can slow the rate of entry of plant oils into

the cells.

Suggest how the low temperature slows the rate of entry.

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(1)

(Total 10 marks)

Q6.

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

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(5)

(b) Describe and explain the processes that occur during meiosis that increase genetic variation.

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(5)

(Total 10 marks)

Q7.

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.

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(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.

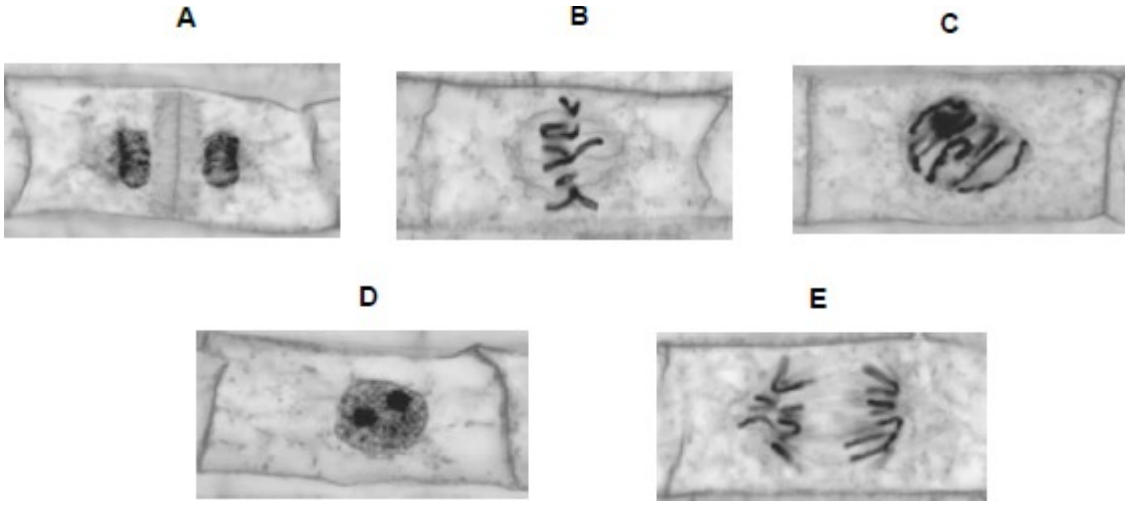
Answer = _____ minutes

(2)

(Total 6 marks)

Q8.

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

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(1)

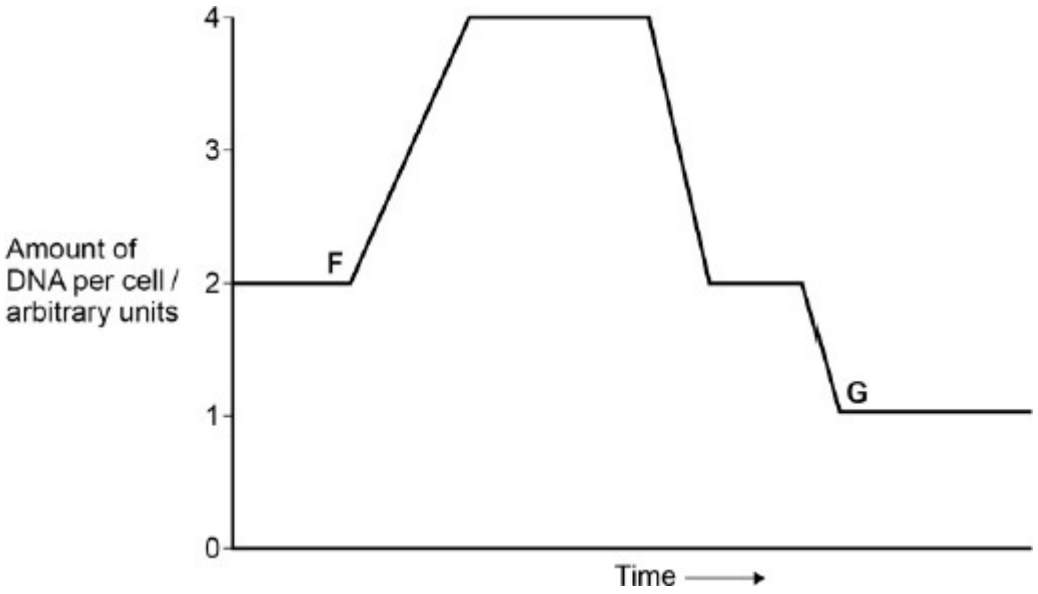
To obtain these images, the onion root tip was cut off, stained and put on a microscope slide. A cover slip was placed on top. The root tip was then firmly squashed and viewed under an optical microscope.

(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**.

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(3)

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

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(1)

(Total 7 marks)

Q9.

Metastatic melanoma (MM) is a type of skin cancer. It is caused by a faulty receptor protein in cell-surface membranes. There have been no very effective treatments for this cancer.

Dacarbazine is a drug that has been used to treat MM because it appears to increase survival time for some people with MM.

Doctors investigated the use of a new drug, called ipilimumab, to treat MM. They compared the median survival time (ST) for two groups of patients treated for MM:

- a control group of patients who had been treated with dacarbazine
- a group of patients who had been treated with dacarbazine and ipilimumab.

The ST is how long a patient lives after diagnosis.

The doctors also recorded the percentage of patients showing a significant reduction in tumours with each treatment.

The total number of patients in the investigation was 502.

The table below shows the doctors' results.

Treatment	Median survival time (ST) / months	Percentage of patients showing significant reduction in tumours
Dacarbazine	9.1	10.3
Dacarbazine and ipilimumab	11.2	15.2

(a) The doctors compared median survival times for patients in each group.

How would you find the median survival time for a group of patients?

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_____

(2)

(b) In many trials of new drugs, a control group of patients is given a placebo that does not contain any drug.

The control group in this investigation had been treated with dacarbazine. Suggest why they had not been given a placebo.

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_____

(1)

(c) A journalist who read this investigation concluded that ipilimumab improved the treatment of MM.

Do the data in the table support this conclusion? Give reasons for your answer.

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(4)

(d) MM is caused by a faulty receptor protein in cell-surface membranes.
Cells in MM tumours can be destroyed by the immune system.

Suggest why they can be destroyed by the immune system.

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(3)

(Total 10 marks)

Q10.

(a) The letters **A**, **B**, **C**, **D** and **E** represent stages in mitosis.

- **A** – anaphase
- **B** – interphase
- **C** – metaphase
- **D** – prophase
- **E** – telophase

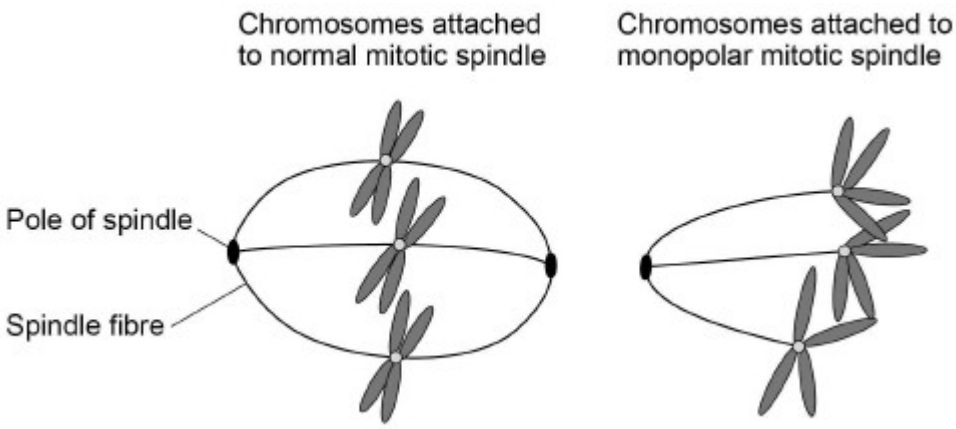
Write **one** of the letters, **A** to **E**, in the box to complete the following statement.

Chromosomes line up on the equator of the mitotic spindle in ☐

(1)

(b) Scientists looking for treatments for cancer are investigating the use of substances called kinesin inhibitors (KI). These inhibitors prevent successful mitosis. Some kinesin inhibitors cause the development of a monopolar spindle in mitosis.

The diagram below shows chromosomes attached to a normal mitotic spindle and to a monopolar mitotic spindle.



Suggest why the development of a monopolar mitotic spindle would prevent successful mitosis.

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(2)

(c) Scientists investigated the effect of different concentrations of a kinesin inhibitor (KI) on mitosis of human bone-cancer cells grown in a culture.

The following table shows the scientists' results.

Concentration of kinesin inhibitor / nmol dm^{-3}	**Percentage of dividing human bone-cancer cells showing a monopolar mitotic spindle**
0	0
1	0
10	8
100	93
1000	100
10 000	100

A student who saw these results concluded that in any future trials of this kinesin inhibitor with people, a concentration of 100 nmol dm^{-3} would be most appropriate to use.

Do these data support the student's conclusion? Give reasons for your answer.

_____

(4)

(d) At the start of their investigation, the scientists made a solution of kinesin inhibitor (KI) with a concentration of 10 000 nmol dm^{-3}. They used this to make the other concentrations by a series of dilutions with water.

Describe how they made 100 cm^3 of 1000 nmol dm^{-3} solution of kinesin inhibitor.

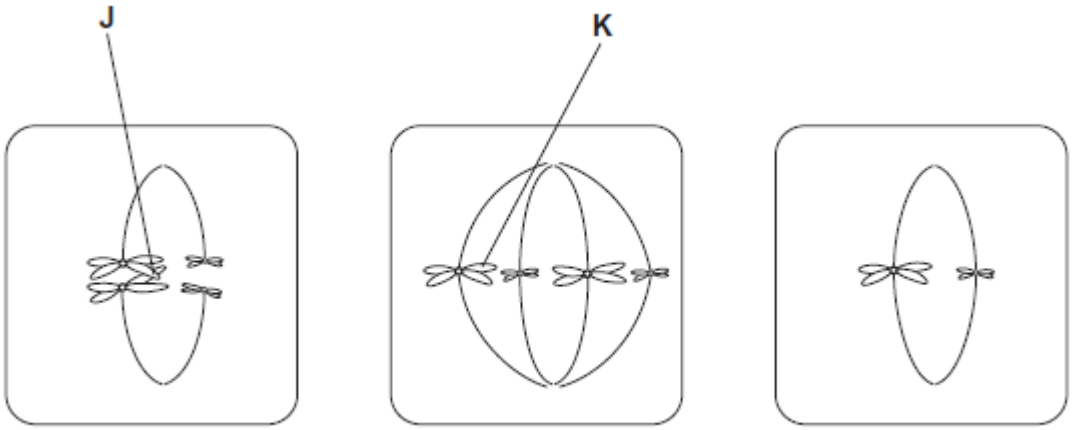
(2)

(Total 9 marks)

Q11.

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**.

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(2)

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

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(2)

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

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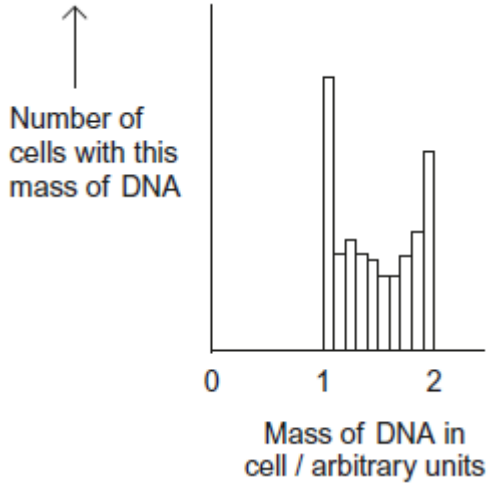
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(1)

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

Figure 2



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

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(1)

(Total 8 marks)

Q12.

In many parts of the world, crops have to be watered to grow enough food but fresh water is often in short supply.

Barley is a plant that grows a leafy shoot and then produces seed that is harvested for food.

Scientists investigated whether barley could be grown successfully using fresh water mixed with seawater. This would reduce the use of fresh water. However, seawater contains dissolved sodium chloride (salt).

The scientists grew barley in plots of equal size in the same large field. Each plot received one of four treatments.

A No watering.
B Watering with fresh water during growth and seed production.
C Watering with a 1:1 mix of fresh water and seawater during growth and seed production.
D Watering with fresh water during growth and with a 1:1 mix of fresh water and seawater during seed production.

At the end of the investigation, the scientists measured the concentration of salt in the soil

in each plot and the yield of barley seed harvested from each plot.

The scientists' results are shown in the table below.

Watering treatment	Mean concentration of salt in soil / arbitrary units	Mean yield of barley seed / g
A	10.1	346
B	9.7	804
C	13.5	538
D	11.6	695

(a) Watering treatment was the independent variable in this investigation.
Explain what is meant by the **independent** variable.

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(1)

(b) The same variety of barley was used in all the plots. Why was this important?

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(2)

(c) When barley plants are growing, the number of cells increases.
Name the process that increases the number of cells.

_____

(1)

(d) What do the data in the table above show about the effect of watering barley with a mixture of fresh water and seawater?

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(2)

(e) The scientists suggested that watering barley with diluted seawater might not be sustainable if repeated every year.
Do these data support this suggestion?

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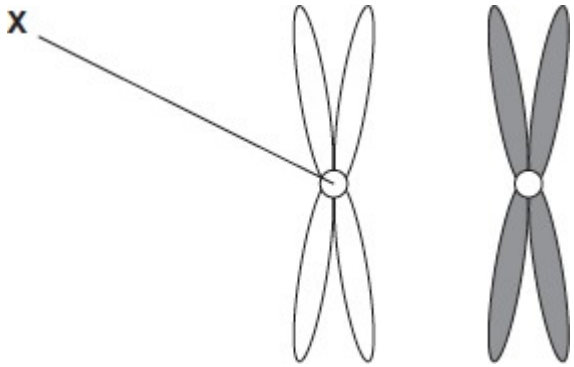
(3)

(Total 9 marks)

Q13.

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

Figure 1



(i) Name **X.**

_____

(1)

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

_____

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(2)

(iii) Homologous chromosomes carry the same genes but they are **not** genetically

identical.Explain why.

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(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.

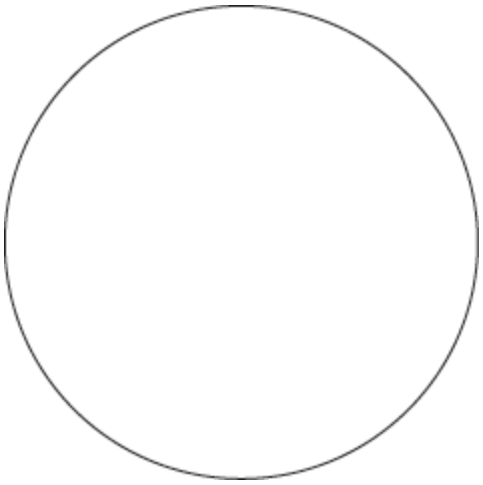
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(1)

(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.

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(1)

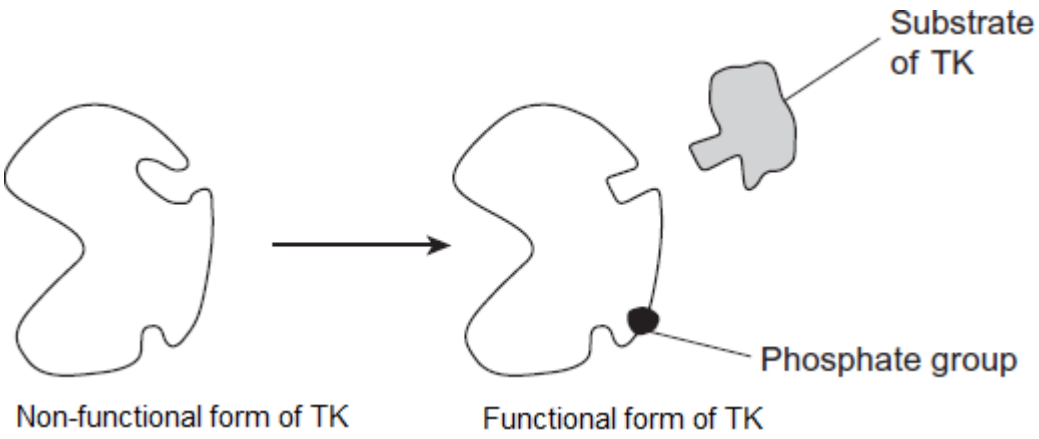
(Total 8 marks)

Q14.

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.**

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.

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_____

(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.

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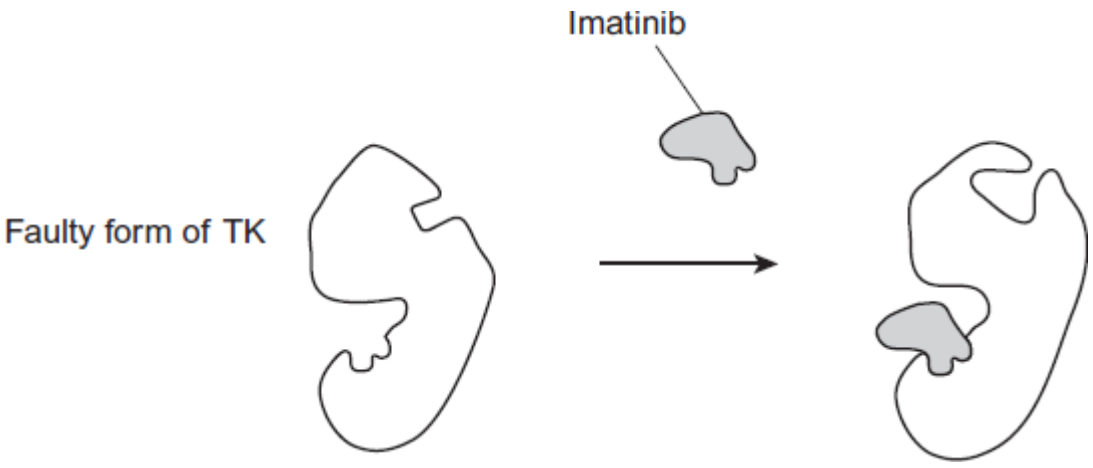
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(2)

(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.

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(2)

(Total 6 marks)

Q15.

(a) Describe how DNA is replicated.

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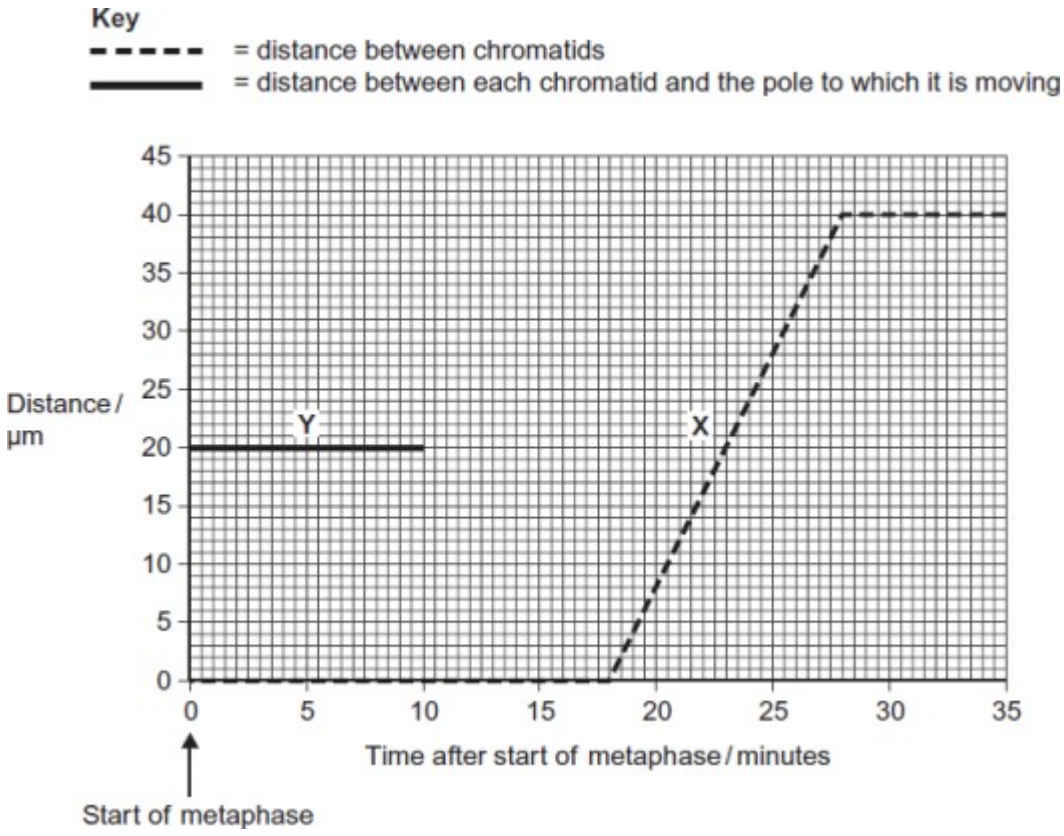
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(6)

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



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

☐ minutes

(1)

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

☐ minutes

(1)

(iii) Complete line **Y** on the graph.

(2)

(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.

	Percentage of cells in each stage of the cell cycle	
Stage of the cell cycle	Tissue sample **C**	Tissue sample **D**
Interphase	82	45
Prophase	4	16

Metaphase	5	18
Anaphase	5	12
Telophase	4	9

(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)

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

_____

_____

_____

(1)

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

_____

_____

_____

_____

_____

(2)

(Total 15 marks)

Q16.

(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.

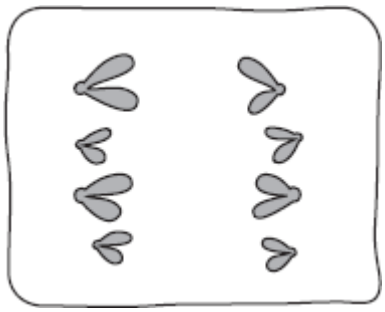
Answer _____

(2)

(Total 9 marks)

Q17.

(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)

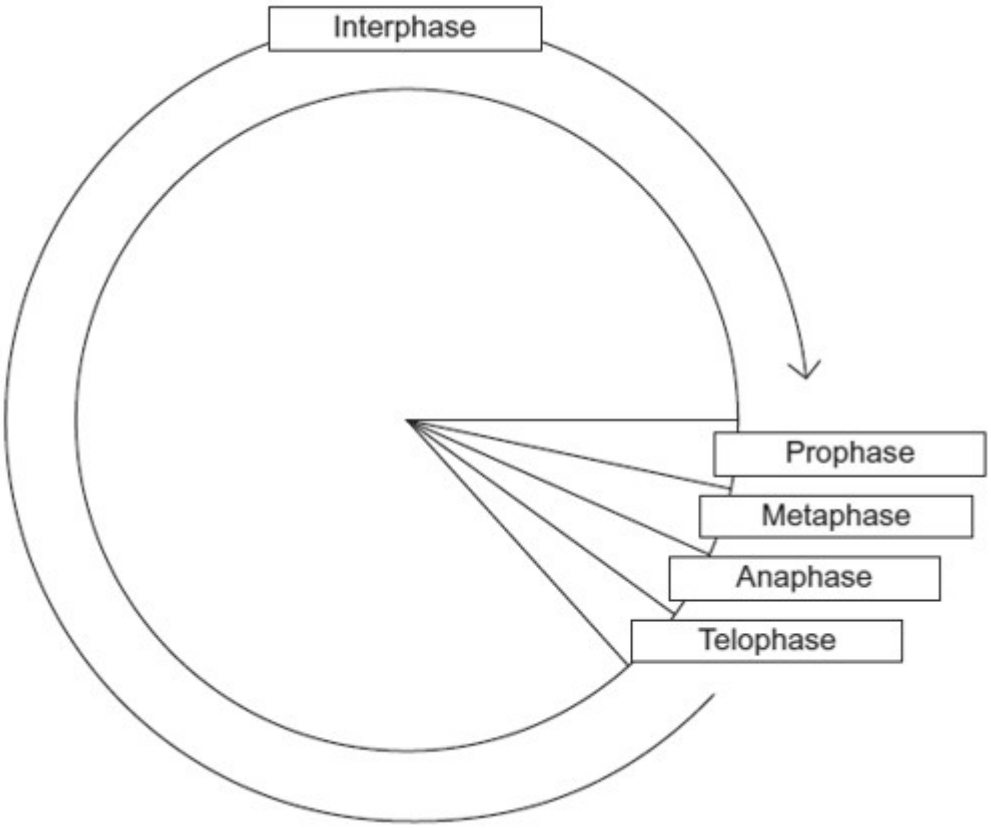
(ii) How many units of DNA would you expect to be present in a gamete formed in this animal as a result of meiosis?

(1)

(Total 6 marks)

Q18.

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)

Q19.

Plant physiologists attempted to produce papaya plants using tissue culture. They investigated the effects of different concentrations of two plant growth factors on small pieces of the stem tip from a papaya plant. Their results are shown in the table.

Concentration of auxin / μmol dm^{-3}	**Concentration of cytokinin / μmol dm^{-3}**		
	5	25	50
0	No effect	No effect	Leaves produced
1	No effect	Leaves produced	Leaves produced
5	No effect	Leaves produced	Leaves and some plantlets produced
10	Callus produced	Leaves and some plantlets produced	Plantlets produced
15	Callus produced	Callus and some leaves produced	Callus and some leaves produced

Callus is a mass of undifferentiated plant cells. Plantlets are small plants.

(a) Explain the evidence from the table that cells from the stem tip are totipotent.

_____

_____

_____

_____

_____

(2)

(b) Calculate the ratio of cytokinin : auxin that you would recommend to grow papaya plants by this method.

Answer _____

(2)

(c) (i) Papaya plants reproduce sexually by means of seeds. Papaya plants grown

from seeds are very variable in their yield. Explain why.

_____

_____

_____

_____

_____

(2)

(ii) Explain the advantage of growing papaya plants from tissue culture rather than from seeds.

_____

_____

_____

(1)

(Total 7 marks)

Q20.

The table shows some differences between three varieties of banana plant.

	Variety **A**	Variety **B**	Variety **C**
Number of chromosomes in a leaf cell	22	33	44
Growth rate of fruit / cm^3 $week^{-1}$	2.9	6.9	7.2
Breaking strength of leaf / arbitrary units	10.8	9.4	7.8

(a) (i) How many chromosomes are there in a male gamete from variety **C**?

(1)

(ii) Variety **B** cannot produce fertile gametes. Use information in the table to explain why.

_____

_____

_____

_____

_____

(2)

In some countries very strong winds may occur. Banana growers in these countries choose to grow variety **B**.

(b) (i) Use the data in the table to explain why banana growers in these countries choose to grow variety **B** rather than variety **A**.

_____

_____

_____

(1)

(ii) Use the data in the table to explain why banana growers in these countries choose to grow variety **B** rather than variety **C**.

_____

_____

_____

(1)

(c) Banana growers can only grow new variety **B** plants from suckers. Suckers grow from cells at the base of the stem of the parent plant.

Use your knowledge of cell division to explain how growing variety **B** on a large scale will affect the genetic diversity of bananas.

_____

_____

_____

_____

_____

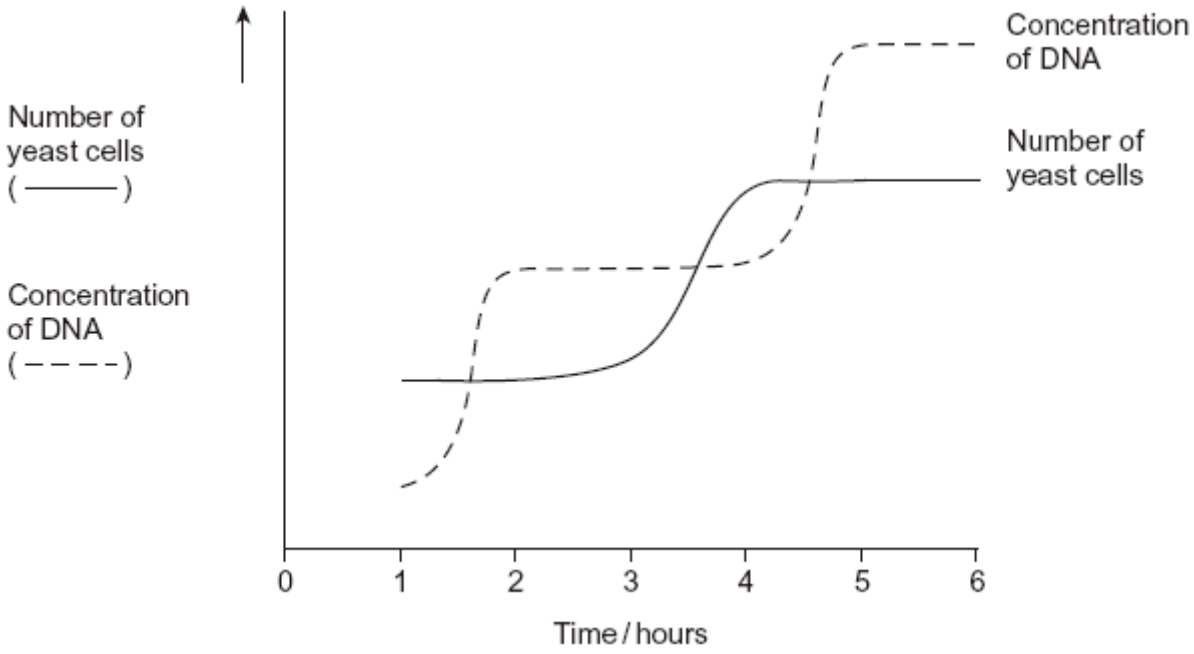
(2)

(Total 7 marks)

Q21.

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)

Q22.

Taxol is a drug used to treat cancer. Research scientists investigated the effect of injecting taxol on the growth of tumours in mice. Some of the results are shown in **Figure 1**.

Figure 1

Number of days of treatment	Mean volume of tumour / mm^3	
	Control group	Group injected with taxol in saline
1	1	1
10	7	2
20	21	11
30	43	20
40	114	48
50	372	87

(a) Suggest how the scientists should have treated the control group.

_____

_____

_____

_____

(2)

(b) Suggest and explain **two** factors which should be considered when deciding the number of mice to be used in this investigation.

1. _____

_____

2. _____

_____

(2)

(c) The scientists measured the volume of the tumours. Explain the advantage of using volume rather than length to measure the growth of tumours.

_____

_____

(1)

(d) The scientists concluded that taxol was effective in reducing the growth rate of the tumours over the 50 days of treatment. Use suitable calculations to support this

conclusion.

(2)

(e) In cells, taxol disrupts spindle activity. Use this information to explain the results in the group that has been treated with taxol.

_____

_____

_____

_____

_____

_____

(3)

(f) The research scientists then investigated the effect of a drug called OGF on the growth of tumours in mice. OGF and taxol were injected into different mice as separate treatments or as a combined treatment. **Figure 2** and **Figure 3** show the results from this second investigation.

Figure 2

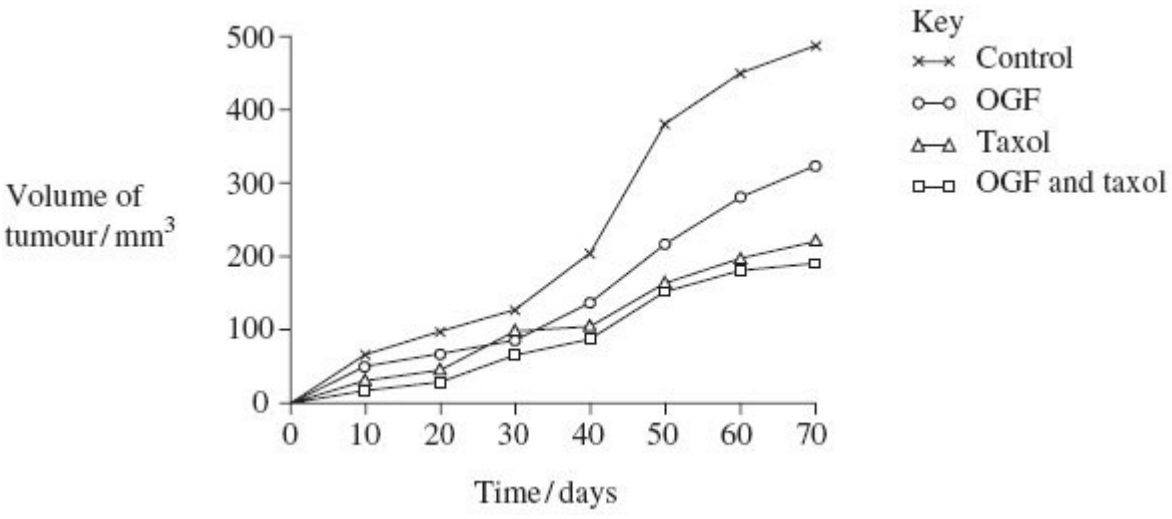


Figure 3

Treatment	Mean volume of tumour following 70 days treatment /mm^3 (± standard deviation)
OGF	322 (± 28.3)

Taxol	207 (± 22.5)
OGF and taxol	190 (± 25.7)
Control	488 (± 32.4)

(i) What information does standard deviation give about the volume of the tumours in this investigation?

_____

_____

(1)

(ii) Use **Figure 2** and **Figure 3** to evaluate the effectiveness of the two drugs when they are used separately and as a combined treatment.

_____

_____

_____

_____

_____

_____

_____

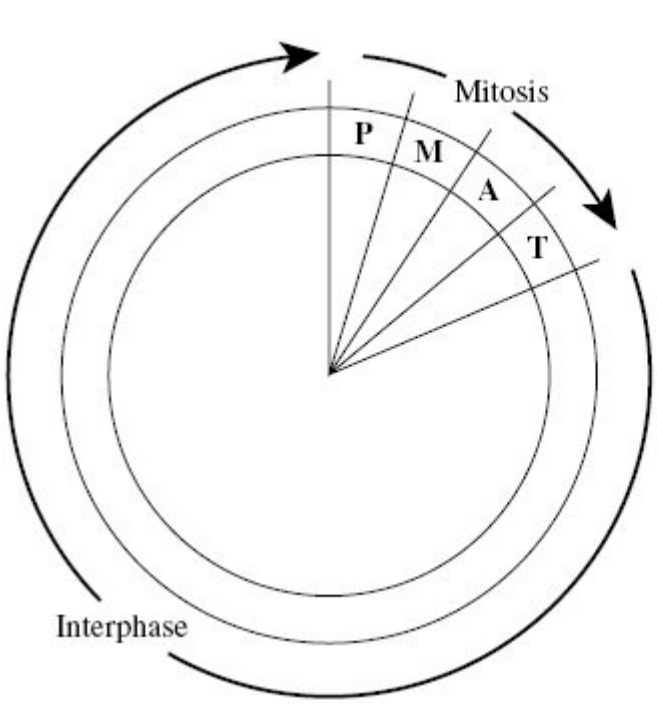
_____

(4)

(Total 15 marks)

Q23.

The diagram shows a cell cycle.



Key

P prophase

M metaphase

A anaphase

T telophase

(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)

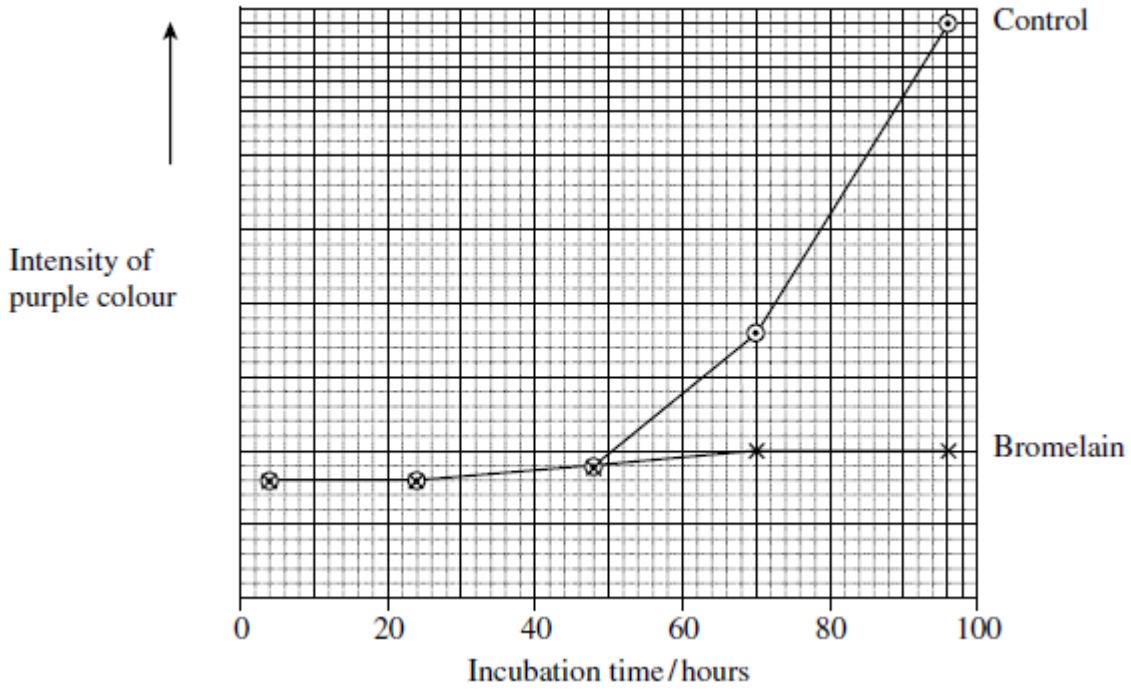
(Total 9 marks)

Q24.

Scientists investigated the effect of bromelain on cancer cells. They took cells from skin cancers in mice and added them to a liquid growth medium in two dishes.

Four hours later they added a solution of bromelain to one of the dishes. They left the other dish as a control. They also added a substance to both dishes that is turned purple by respiring cells.

Both dishes were placed in an incubator. The scientists measured the intensity of the purple colour at intervals over a period of 100 hours.



(a) The scientists put the same number of skin tumour cells in each dish at the start of this investigation. Explain why it was important to put the same number of cells in each dish.

_____

_____

(1)

(b) The scientists concluded that bromelain did not kill cancer cells but stopped them dividing. Does the graph support this conclusion? Explain your answer.

_____

_____

_____

_____

(2)

(c) An article in a newspaper claimed that these data show that bromelain can be used to treat cancer.

Give **three** reasons why we should be careful about accepting this claim.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(d) The rate of cell division is important in investigations into cancer. Suggest why.

_____

_____

_____

_____

(2)

(e) Scientists have investigated the effects of bromelain on cancer growth in humans. Suggest why they gave bromelain in addition to, rather than instead of, the usual treatment.

_____

_____

_____

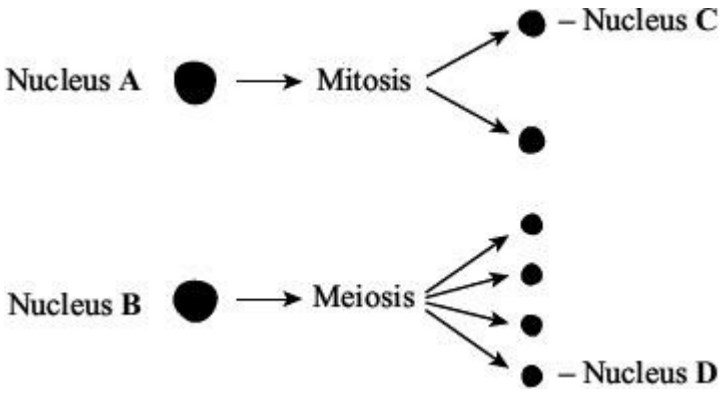
_____

(2)

(Total 10 marks)

Q25.

(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)

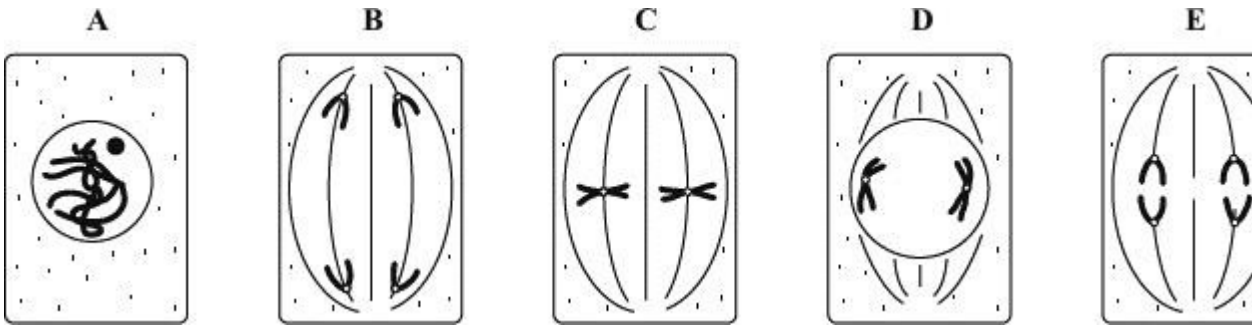
Q26.

(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)

Q27.

Read the following passage.

The idea that bacteria could be used as a cancer treatment originated over 100 years ago. A doctor noticed that some cancer patients with bacterial infections showed signs of recovery from the cancer. Attempts to use the bacteria as a treatment were disappointing, however. Experiments showed that the bacteria made an impressive onslaught on tumours, but a ring of cancerous tissue around the edge usually survived.

Bacteria are once again being used in the war on cancer. Scientists have genetically engineered a harmless strain of *Clostridium* to carry the gene for an enzyme. This enzyme converts a harmless “prodrug” into an active drug which acts as a powerful toxin. In people, this strain of *Clostridium* will only grow in tumours. Scientists hope that when they inject the prodrug into a cancer patient’s blood, the bacteria will convert it into an active drug. This will destroy tumours from the inside, leaving healthy tissues unharmed.

The idea of converting a harmless prodrug into an active drug that only kills cancer cells is not new. Apart from the use of genetically modified *Clostridium*, other methods have been tried. One of these involved attaching an enzyme to an antibody that binds only to cancer cells. This enzyme then activates the drug. Unfortunately, different types of cancer require different antibodies, making the treatment expensive to develop. Scientists hope their bacterial approach will offer a way of delivering the enzymes to any cancer cell.

(a) Describe how scientists could genetically engineer *Clostridium* bacteria to produce the enzyme which activates the prodrug. (lines 7-8)

(6)

(b) Explain why it is important to destroy all the cancer cells in a tumour.

(2)

(c) Explain how the use of antibodies (lines 16-17) results in a drug only killing cancer cells.

_____

_____

(3)

(d) Cancer drugs usually interfere with DNA replication. Use this information to explain why the cancer drugs are administered as prodrugs and not the active form.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 15 marks)

Q28.

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. _____

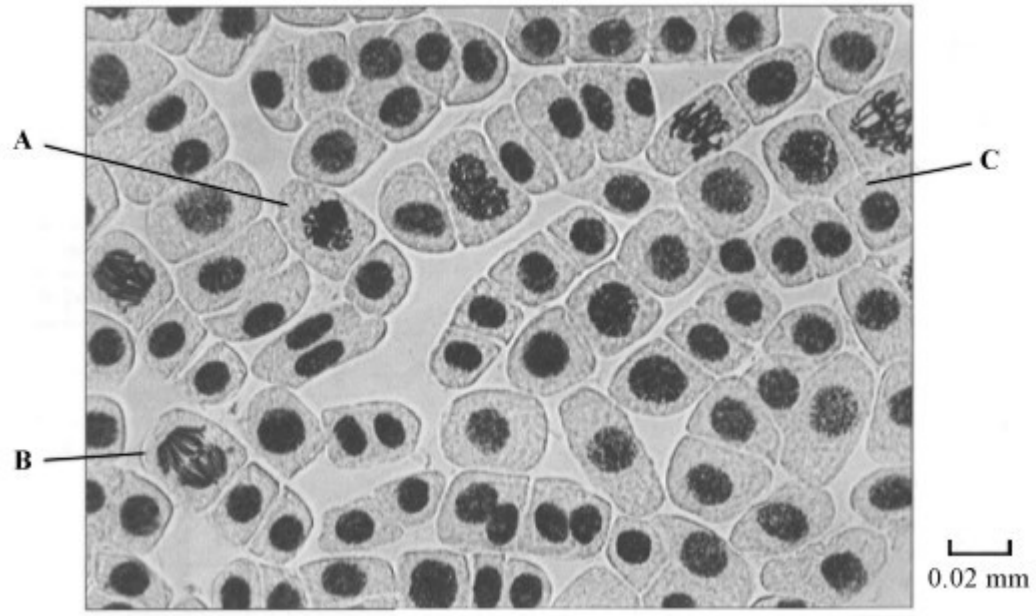
_____

(2)

(Total 7 marks)

Q29.

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)

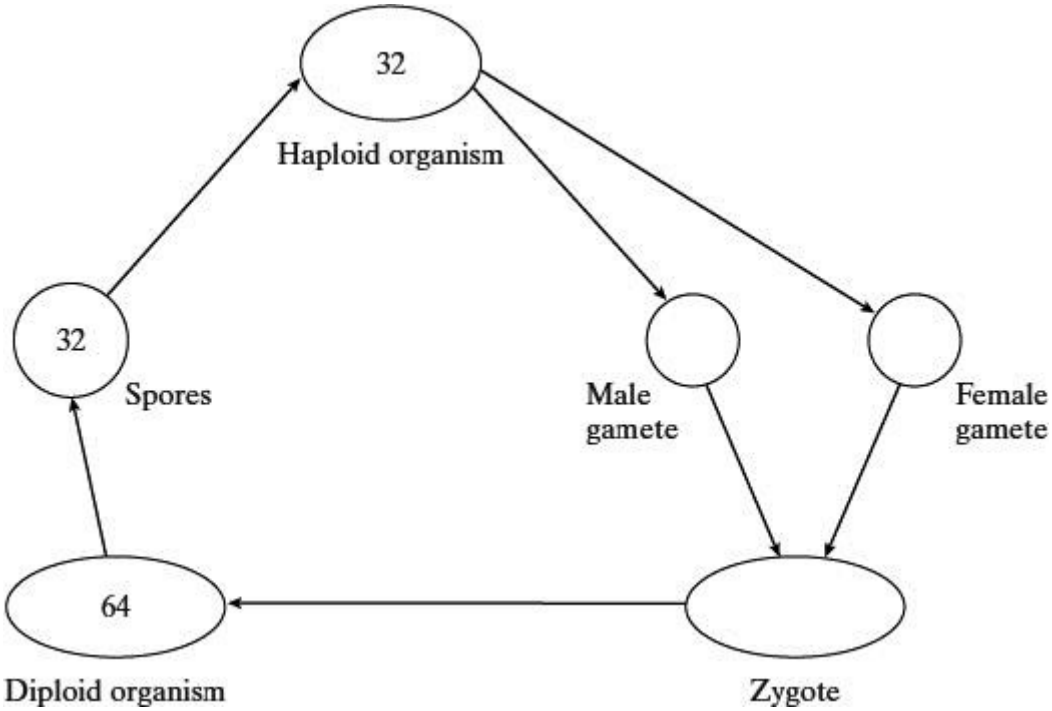
Q30.

(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)

Q31.

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)

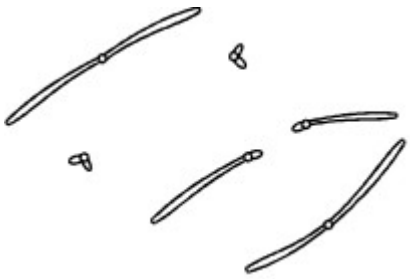
Q32.

(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)

Q33.

(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.

_____

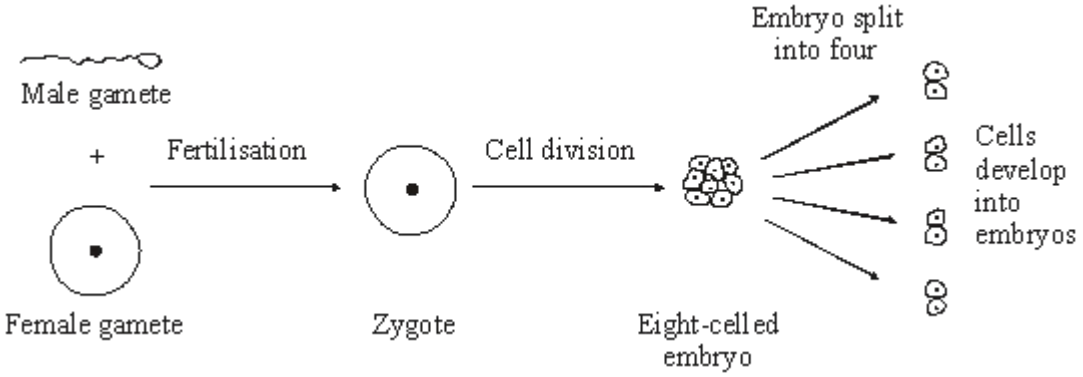
_____

(1)

(Total 7 marks)

Q34.

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)

Q35.

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

A	Chromatids seperate
B	Nuclear envelopes 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)

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

_____

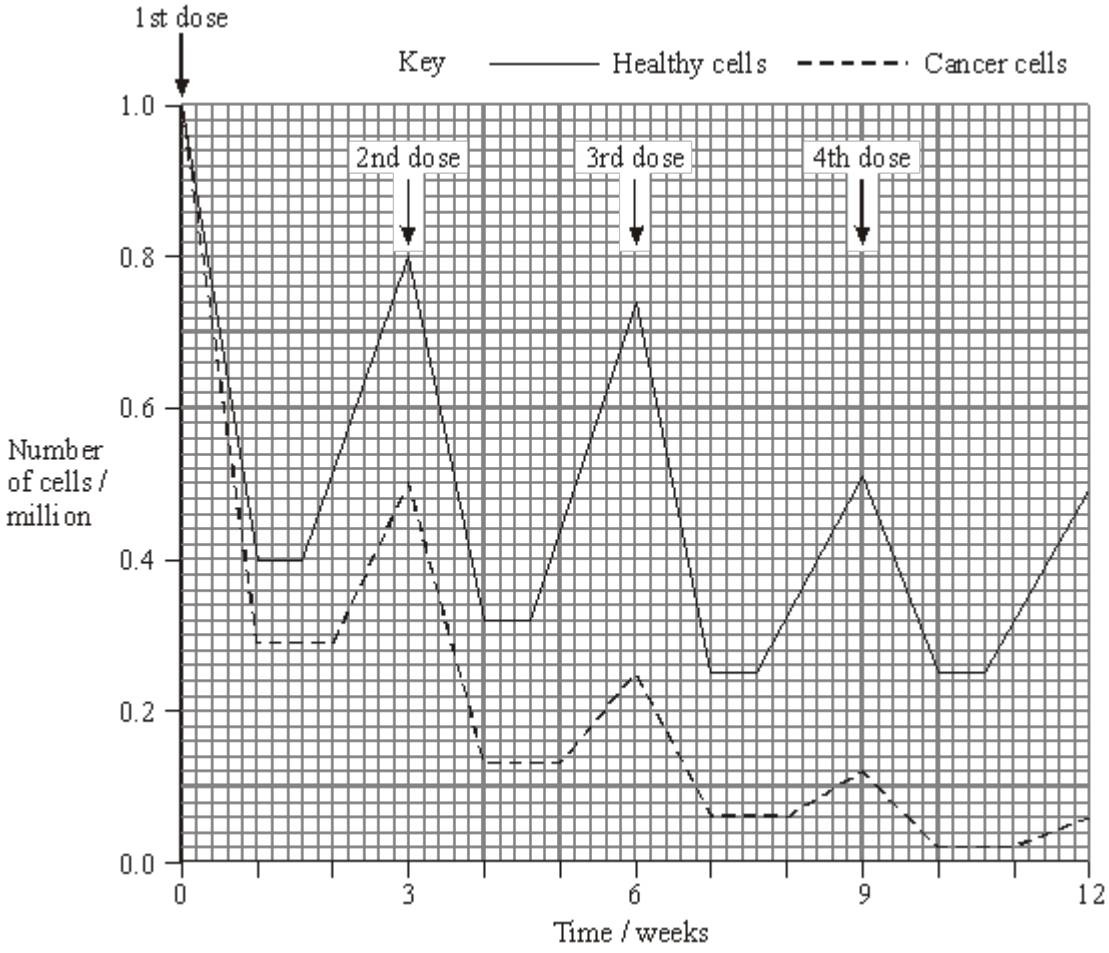
(1)

(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. _____

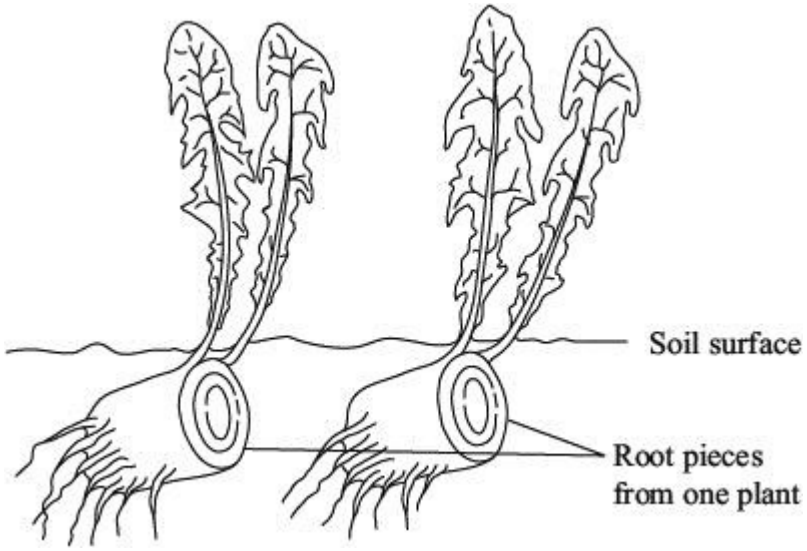
_____

(2)

(Total 8 marks)

Q36.

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)

Q37.

(a) Describe and explain how the structure of DNA results in accurate replication.

(4)

(b) Describe the behaviour of chromosomes during mitosis and explain how this results in the production of two genetically identical cells.

(7)

(c) A cancerous tumour is formed by uncontrolled mitotic division. This results in a mass of cells with an inadequate blood supply. Drugs are being developed which only kill cells in a low oxygen environment. Suggest how these drugs could be useful in the treatment of cancer.

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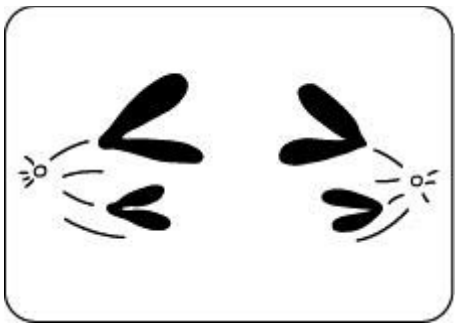
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(2)

(Total 13 marks)

Q38.

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



(i) Name this stage of mitosis.

_____

(1)

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

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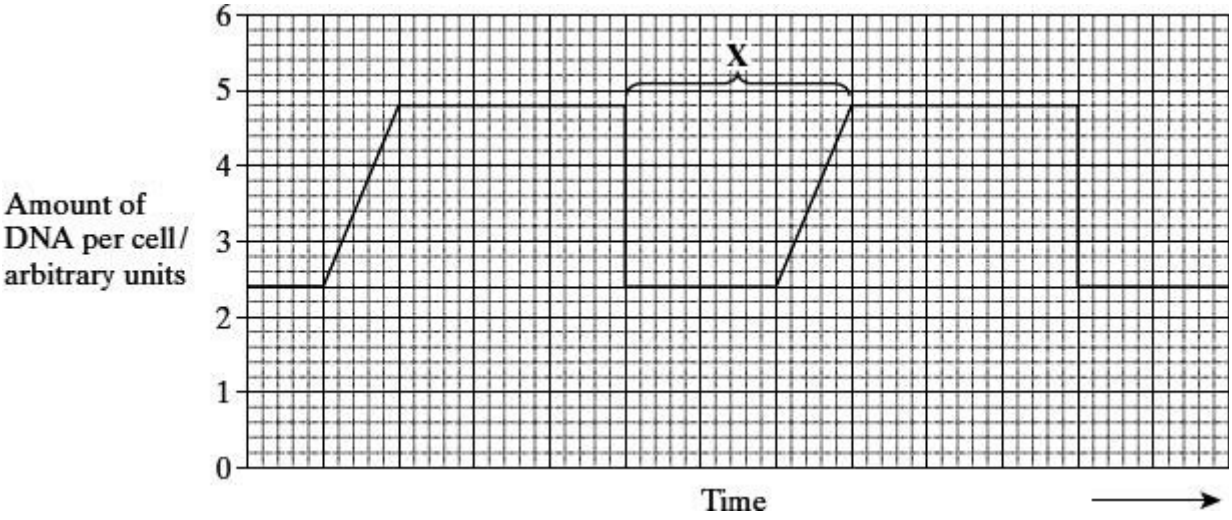
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(2)

(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)

(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)

(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)

(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.

_____

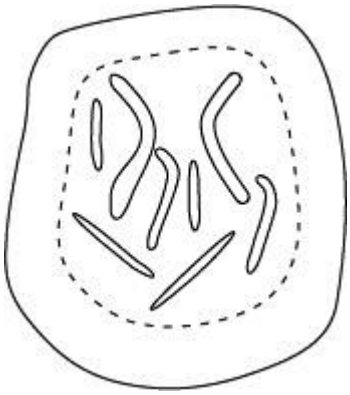
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(1)

(Total 7 marks)

Q39.

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.

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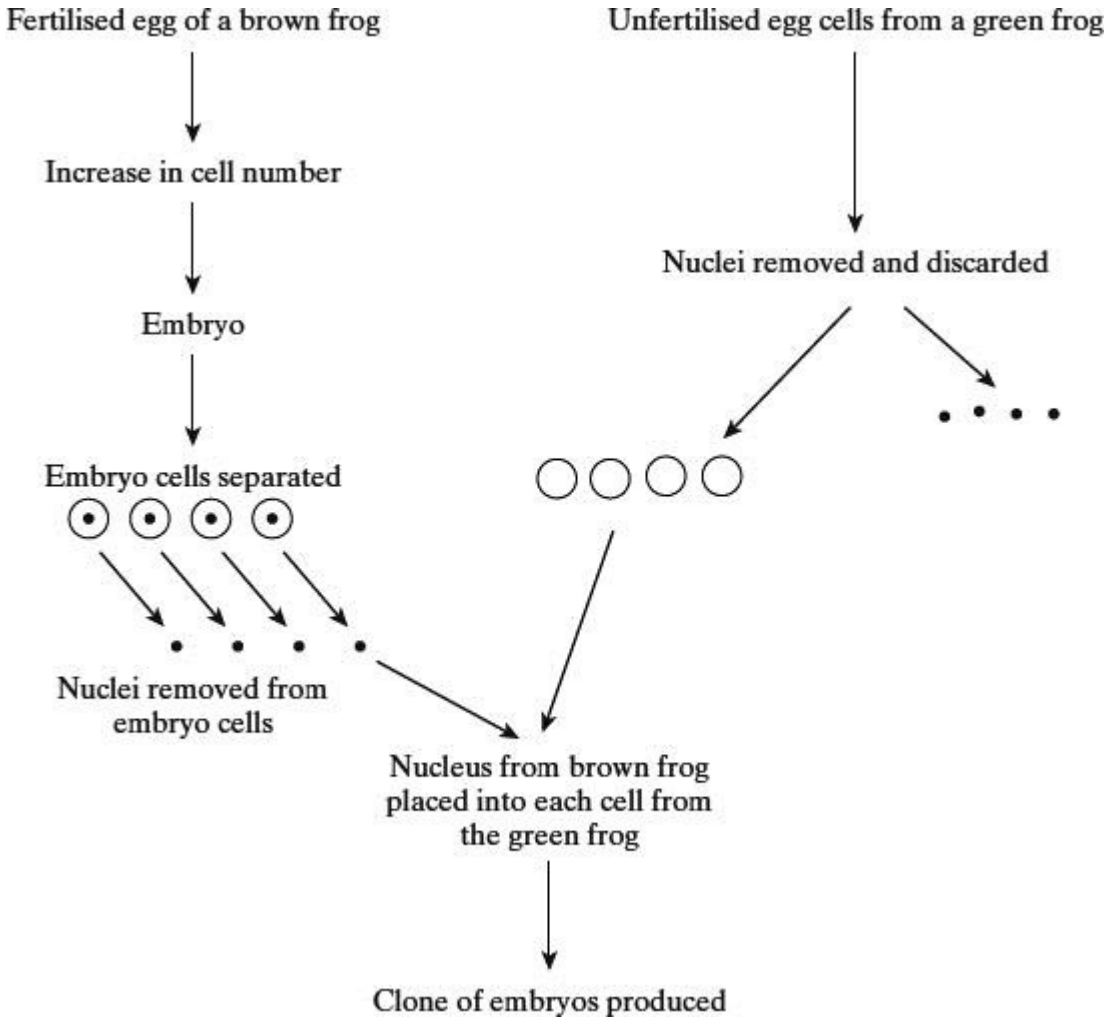
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(2)

(Total 6 marks)

Q40.

A clone of frogs was produced by nuclear transfer. This procedure is summarised in the diagram.



(a) What is a clone?

_____

_____

(1)

(b) Name the type of cell division occurring in a developing embryo.

_____

(1)

(c) The embryo cells used are from an early stage of development. Explain why.

_____

_____

(1)

(d) What would be the colour of the cloned offspring? Explain your answer.

_____

_____

(1)

(e) Give **two** differences between the nuclei removed from the embryo cells and the nuclei discarded from the unfertilised egg cells.

1. _____

2. _____

(2)

(f) Only 30% of the cloned cells successfully developed into embryos.
Suggest a reason for this low success rate.

_____

_____

(1)

(Total 7 marks)

Q41.

Research scientists can increase the nutritional value of potatoes by genetically engineering potato plants. A gene which results in increased protein production has been removed from cells of an amaranth plant and inserted into cells of a potato plant.

(a) Describe how a gene could be removed from cells of an amaranth plant and inserted into cells of a potato plant.

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(6)

(b) Whole potato plants can be produced from genetically identical potato cells grown in a tissue culture. Use your knowledge of genes to suggest how different cells, such as leaf and root cells, can develop from genetically identical cells.

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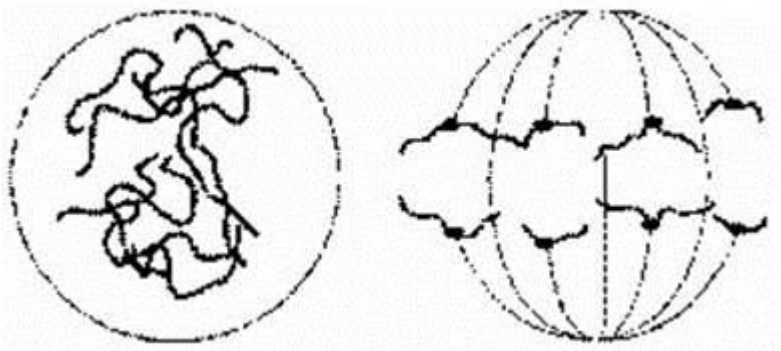
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(2)

(Total 8 marks)

Q42.

(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. _____

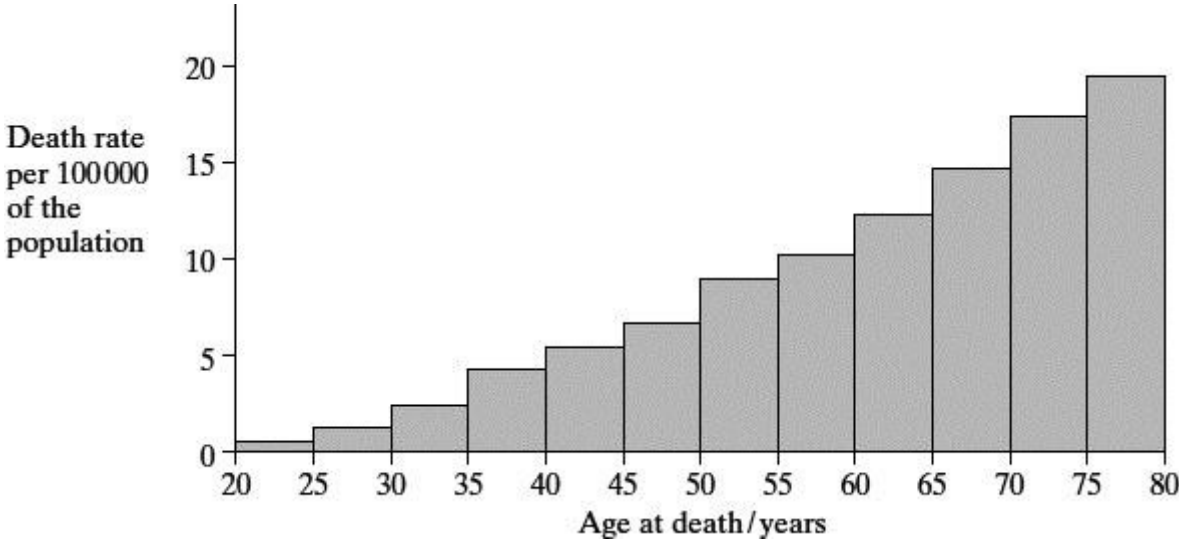
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(2)

(Total 6 marks)

Q43.

The death rate from malignant skin tumours was investigated in the USA. The graph shows the results for fair-skinned men in different age groups.



(a) Describe what is meant by a *malignant tumour*.

_____

_____

_____

_____

_____

_____

(3)

(b) Give **one** reason for the change in death rate from malignant skin tumours with increasing age.

_____

_____

(1)

(c) The data for fair-skinned and dark-skinned people were collected separately. Explain why skin colour was a factor likely to affect the death rate.

_____

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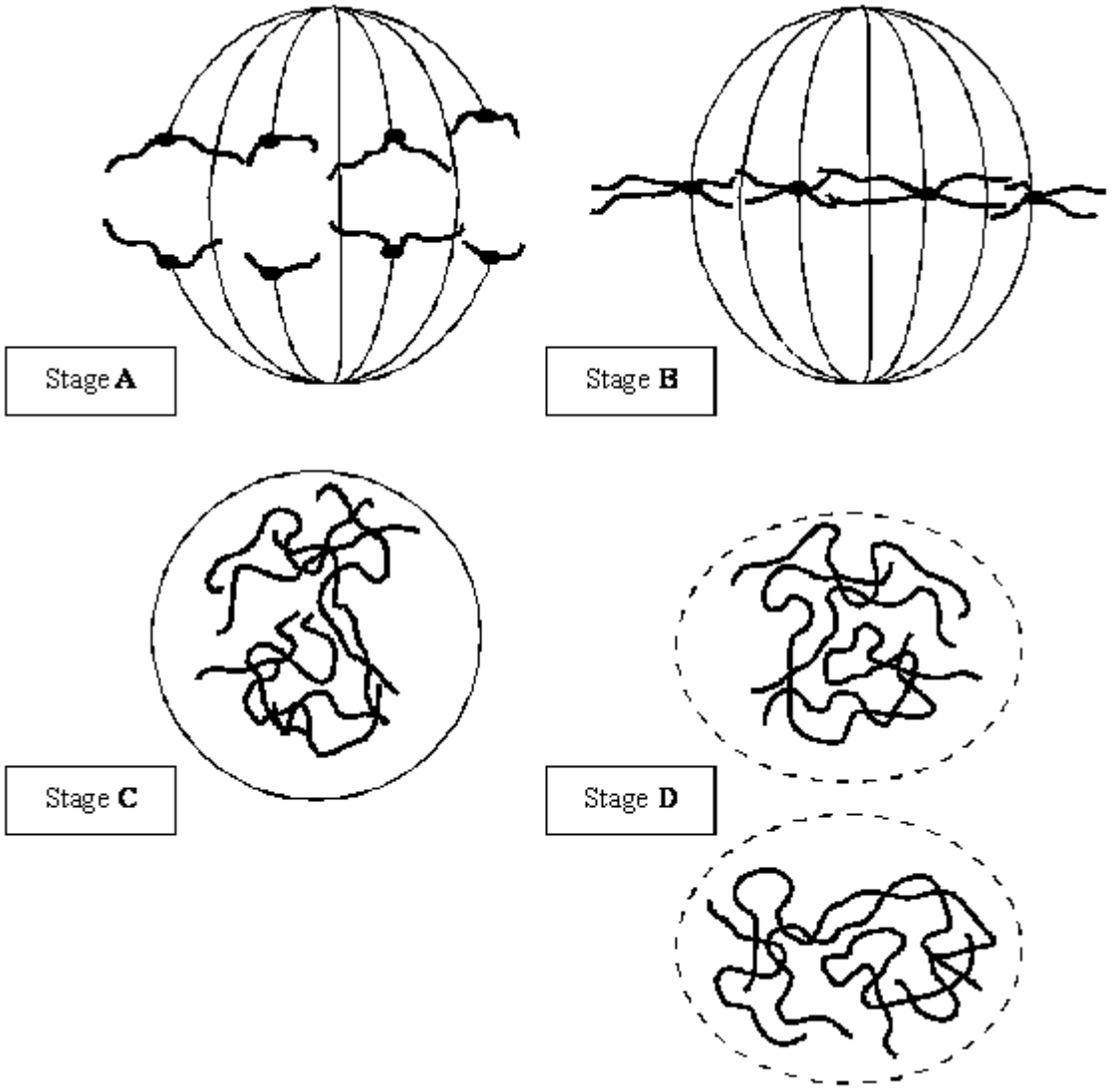
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(2)

(Total 6 marks)

Q44.

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**.

_____

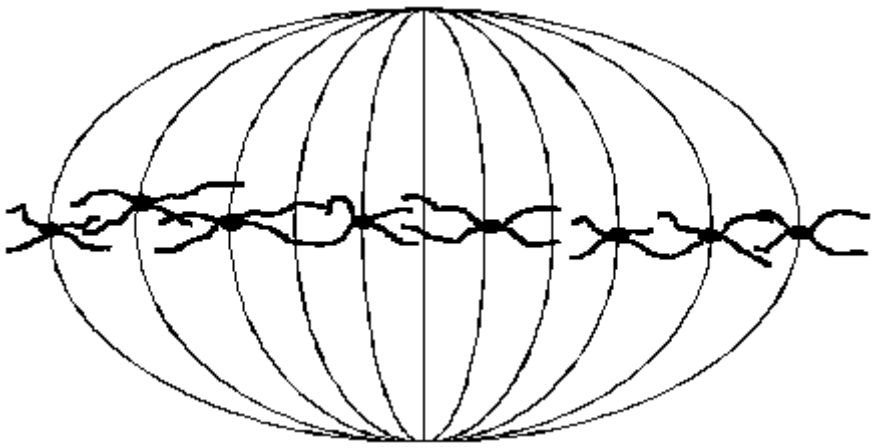
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(2)

(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.

_____

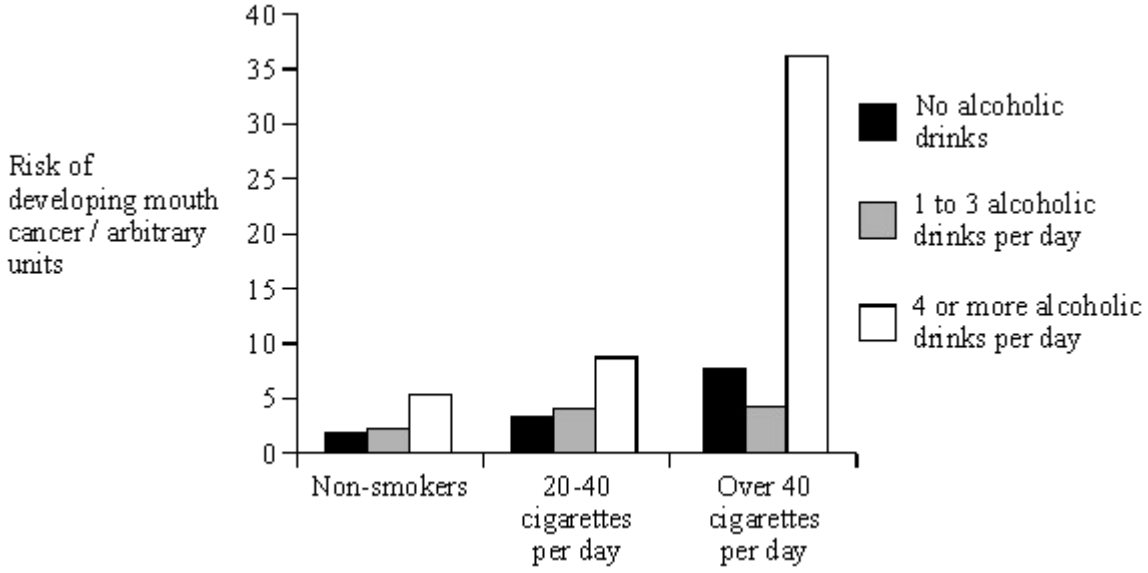
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(1)

(Total 6 marks)

Q45.

The bar chart shows the effects of smoking and alcoholic drinks on the risk of developing mouth cancer.



(i) Describe the effects of smoking and drinking on the risk of developing mouth cancer.

_____

_____

_____

_____

_____

_____

(3)

(ii) Suggest **one** reason why people who neither drink nor smoke sometimes develop mouth cancer.

_____

_____

(1)

(Total 4 marks)