1. In 1984 the first useful DNA sequences were extracted from the dried muscle tissue of the quagga, a zebra-like animal that became extinct in 1883. Copies of the DNA sequences were obtained by inserting the DNA into bacteria which replicated them - a process called cloning. Among the clones of the quagga DNA a sequence of 229 base pairs was obtained. This was compared with the corresponding DNA sequence in the mountain zebra and was found to differ by only 12 base pairs.

(a) Explain how the differences between the DNA sequences from the quagga and the mountain zebra may have arisen as a result of mutation.

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(3)

(b) Describe the molecular structure of DNA and explain how a sequence of DNA is replicated in the bacteria.

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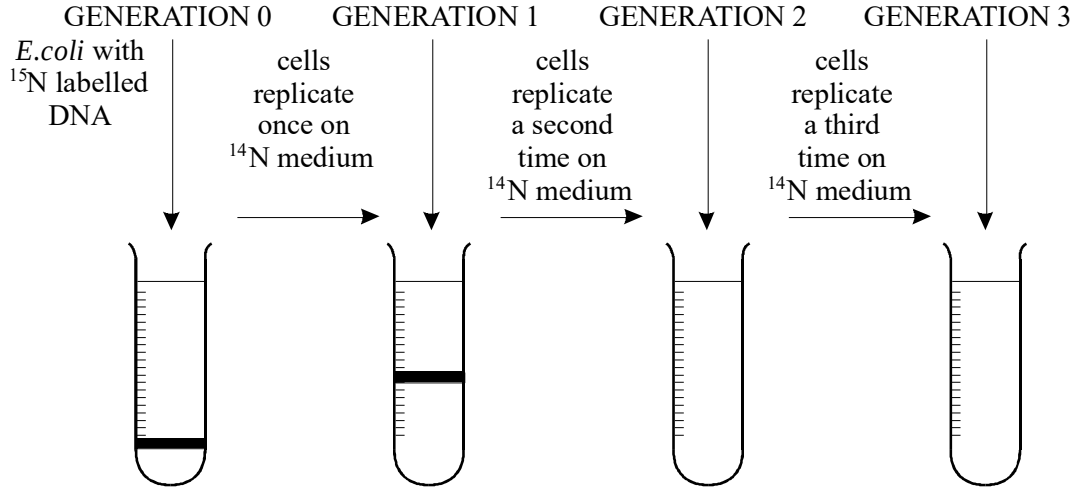
(9)
(Total 12 marks)

2. There are two forms of nitrogen. ^{15}N is a heavier isotope than the normal isotope ^{14}N.
In an investigation, a culture of the bacterium *Escherichia coli* was obtained in which all the nitrogen in the DNA was of the ^{15}N form. The bacteria were transferred to a medium containing only the normal isotope. '^{4}N, and allowed to divide once. A sample of this first generation was removed. The DNA was then extracted and spun in a high-speed centrifuge. This was done again with samples of the second and third generations.
The diagram shows the results of this investigation.



(a) Which part of a DNA nucleotide contains nitrogen?

.....

(1)

(b) Explain why the DNA from generation 1 is found in the position shown.

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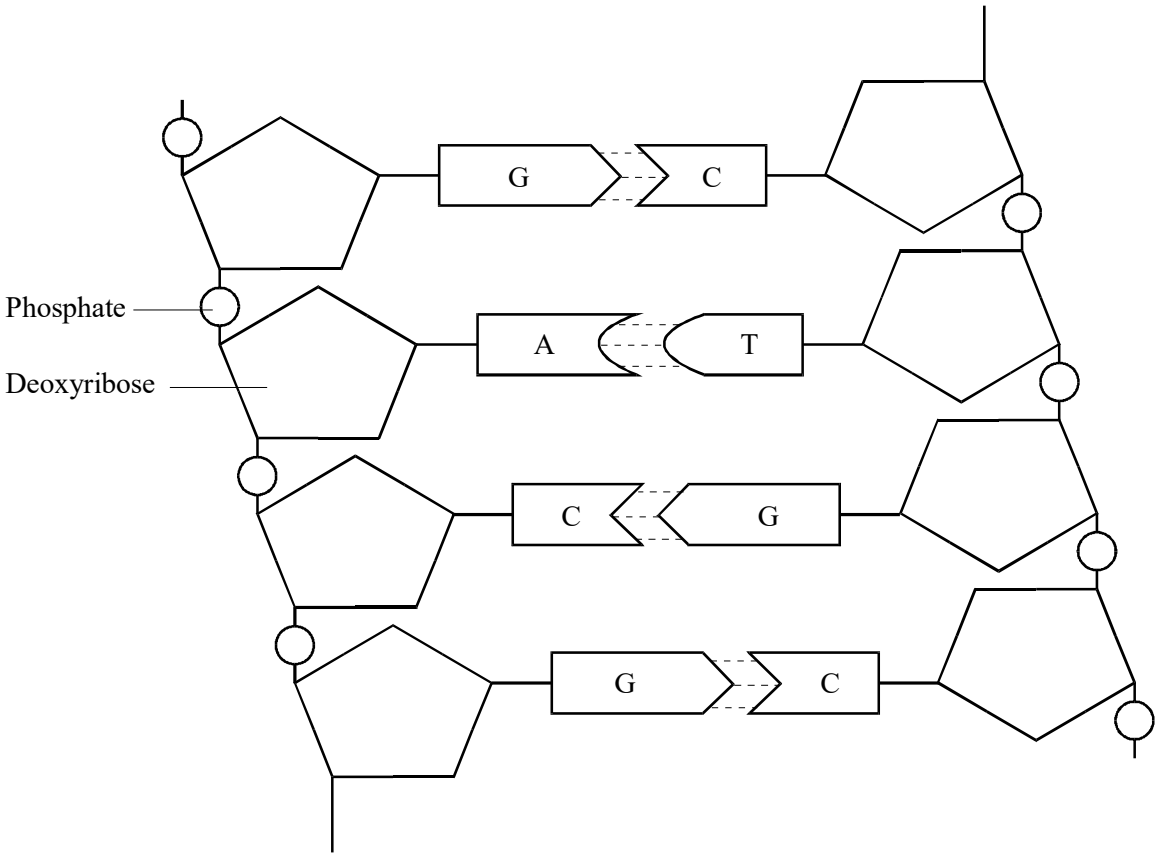
(2)

(c) Complete the diagram to show the positions of the DNA from generations 2 and 3.

(2)

(Total 5 marks)

3. The drawing shows part of a DNA molecule.



(a) Describe the structural features shown in the drawing which account for the ability of the molecule to replicate itself.

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(2)

(b) One piece of experimental evidence for the semi-conservative mechanism for replication of DNA involves the use of bacteria labelled with the heavy isotope of nitrogen, ^{15}N.

(i) Which component of DNA would be labelled with ^{15}N?

.....

(1)

(ii) Explain how DNA labelled with ^{15}N could be separated and distinguished from DNA containing ^{14}N.

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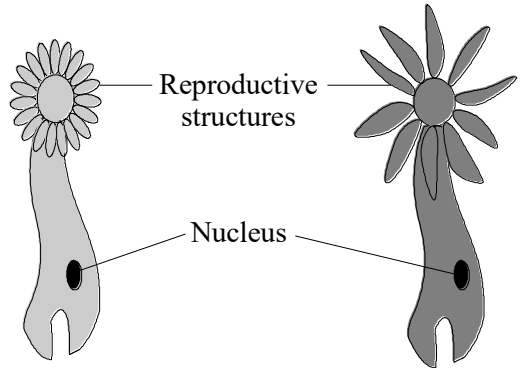
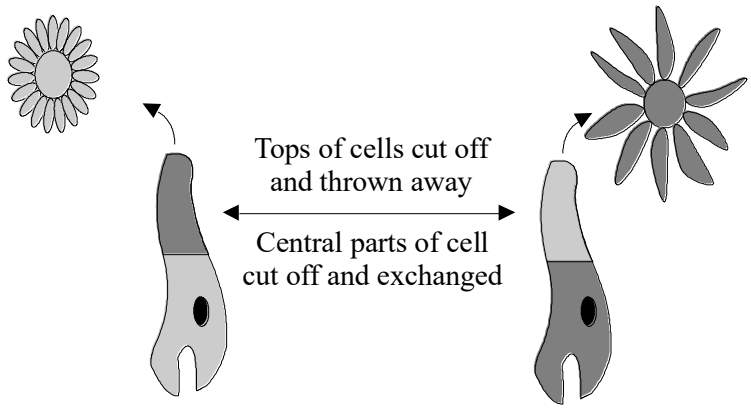
(3)
(Total 6 marks)

4. *Acetabularia* is a single-celled alga. There are two different species which differ mainly in the shape of the reproductive structures they produce. These species were used in early research into inheritance.

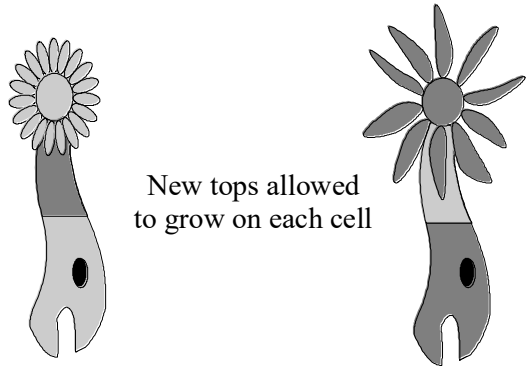


Acentabularia mediterranea *Acentabularia crenulata*

The tops were cut off two cells and thrown away. The central parts of the cells were then cut off and exchanged.



Each cell was then allowed to grow a new top, which requires the synthesis of new proteins.



(a) Explain how the results suggest that the information for inherited characteristics is found in the nucleus, and not in the cytoplasm.

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(3)

(b) Explain how the results suggest that a substance passes from the nucleus to the cytoplasm bringing about protein synthesis.

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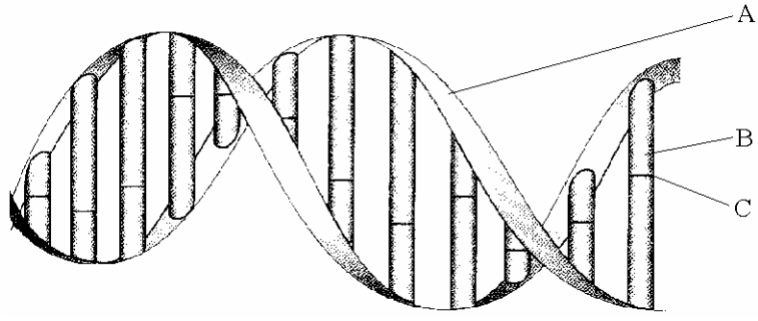
(2)
(Total 5 marks)

5. The diagram shows part of a DNA molecule.



(a) DNA is a large molecule made up of a large number of nucleotides. Each nucleotide has three components.

(i) Name the components that make the parts of the DNA molecule labelled **A** and **B.**

A .....

and .....

B .....

(3)

(ii) Name the type of bond found at **C.**

.....

(1)

(b) 1 kilobase of DNA is a length of a DNA molecule with 1000 base pairs.
The length of I kilobase is 0.34 micrometres (μm).
The DNA in a human cell contains a total of 2 900 000 kilobases.
Calculate the total length of DNA in a human cell. Give your answer in millimetres (mm). Show your working.

Length .....mm

(2)

(c) Give **three** ways in which the structure of the DNA molecule enables it to carry out its functions.

1 .....

.....

2 .....

.....

3 .....

.....

(3)
(Total 9 marks)

6. (a) A nucleotide of DNA contains an organic base and two other components.
Name the **two** other components.

1 .....

2 .....

(2)

(b) A piece of DNA consisted of 17 base pairs. This piece was analysed to find how many bases of each type were present in each of its two strands. Some of the results are shown in the table.

	Number of bases			
	A	T	G	C
Strand A	6			2
Strand B				5

Calculate the missing values for the number of bases and complete the table.

(2)

(c) The cells in the heart and liver of a person are genetically identical but different in appearance. Use your knowledge of genes to suggest why these cells are different in appearance.

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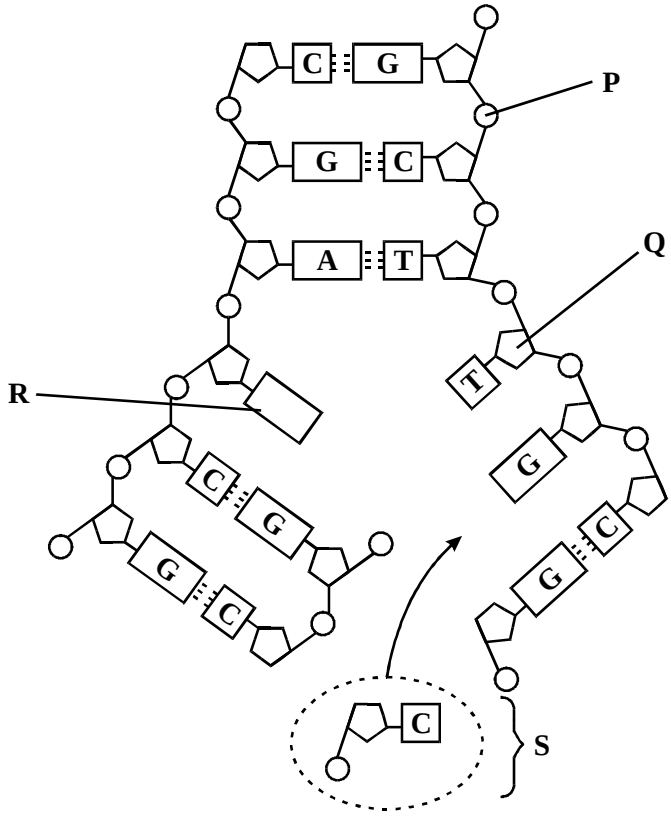
(2)

(Total 6 marks)

7. The diagram shows part of a DNA molecule in the process of replication.



(a) Name parts **P** to **S**.

P .....

Q .....

R .....

S .....

(4)

(b) Which enzyme joins part **S** to the new DNA strand?

.....

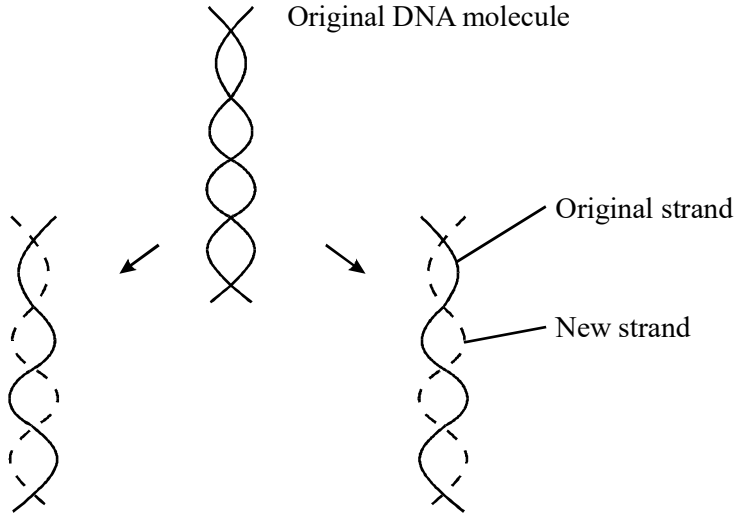
(1)

(c) During which stage of the cell cycle does DNA replication occur?

.....

(1)
(Total 6 marks)

8. The diagram shows the replication of a molecule of DNA.



(a) Explain why DNA replication is described as *semi-conservative*.

.....

.....

(1)

(b) (i) What is meant by *specific base pairing?*

.....

.....

(ii) Explain why specific base pairing is important in DNA replication.

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(3)

(c) Describe **two** features of DNA which make it a stable molecule.

1 .....

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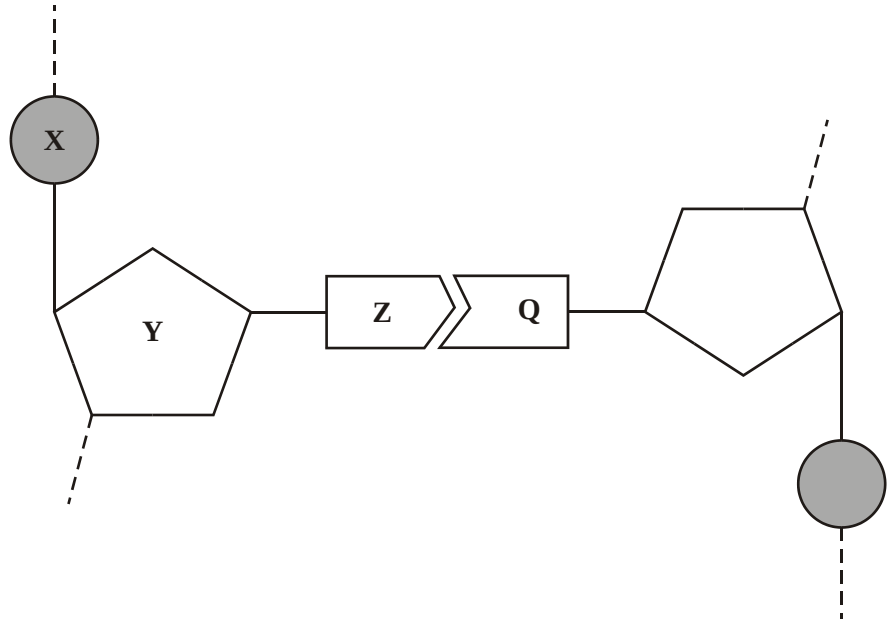
2 .....

.....

(2)

(Total 6 marks)

9. The diagram shows one nucleotide pair of a DNA molecule.



(a) Name the parts of the nucleotide labelled **X**, **Y** and **Z**.

X .....

Y .....

Z .....

(3)

(b) What type of bond holds **Z** and **Q** together?

.....

(1)

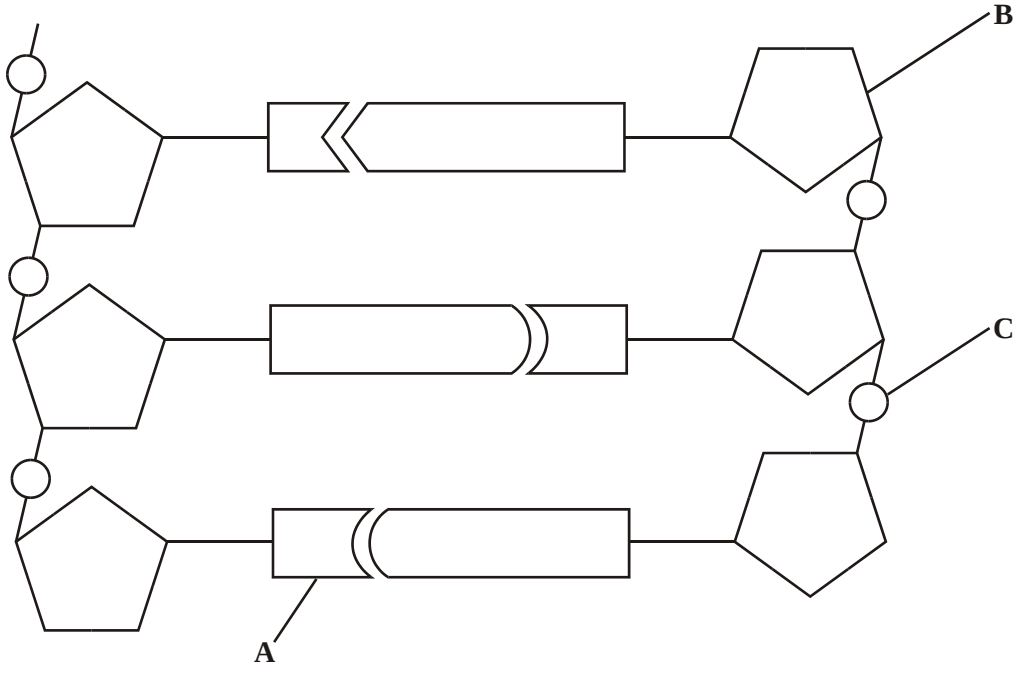
(c) A sample of DNA was analysed. 28% of the nucleotides contained thymine. Calculate the percentage of nucleotides which contained cytosine. Show your working.

Answer ..... %

(2)

(Total 6 marks)

10. The diagram shows a short section of a DNA molecule.



(a) On the diagram draw a box round **one** nucleotide.

(1)

(b) Use the letters in the diagram to indicate a part of the molecule which

(i) is **not** a base and is different in an RNA molecule; .....

(ii) contains nitrogen. .....

(2)

(c) (i) The sequence of bases on one strand of DNA is important for protein synthesis. What is its role?

.....

.....

(1)

(ii) How are the two strands of the DNA molecule held together?

.....

(1)

(iii) Give **one** advantage of DNA molecules having two strands.

.....

.....

(1)

(Total 6 marks)

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

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(4)

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

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(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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(2)

(Total 13 marks)

12. (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**.

.....

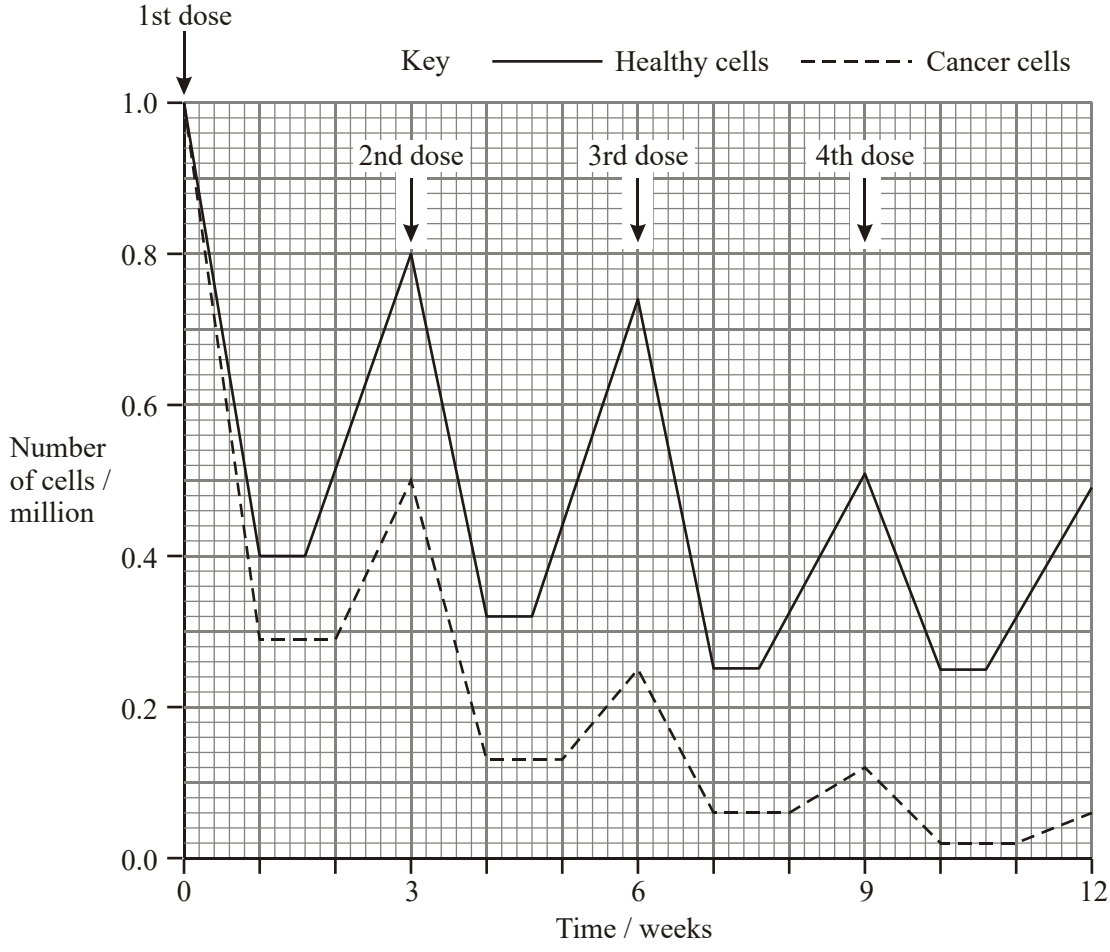
(1)

(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.

.....

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(1)

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

1 .....

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2 .....

.....

(2)

(Total 8 marks)