

1. Explain each of the following statements in terms of your knowledge of the structure and function of DNA.

(i) In all living organisms the ratio  $\frac{A+C}{T+G}$  is constant but the ratio  $\frac{A+T}{G+C}$  varies from one species to another.

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(3)

(ii) The DNA which codes for the human protein,  $\alpha$ -globin, has 850 base pairs but there are only 141 amino acids in this protein.

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(1)

(Total 4 marks)

2. (a) **Table 1** shows the percentage of different bases in DNA from different organisms.

Source of DNA	Adenine %	Guanine %	Thymine %	Cytosine %
Human	30	20	30	20
Rat	28	22	28	22
Yeast	31	19	31	19
Turtle	28	22	28	22
<i>E.coli</i>	24			
Salmon	29	21	29	21
Sea urchin	33	17	33	17

**Table 1**

- (i) What information about the ratios of the different bases in DNA can you work out from the table?

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(2)

- (ii) Give the results that you would expect for DNA from the *E.coli* bacterium.  
Explain how you arrived at your answer.

Guanine ..... Thymine ..... Cytosine .....

Explanation .....

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(3)

- (iii) Turtles have the same percentages of the four different bases as rats. Explain why they can still be very different animals.

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(1)

(b) **Table 2** shows the percentage of different bases in the DNA from a virus.

<b>Adenine %</b>	<b>Guanine %</b>	<b>Thymine %</b>	<b>Cytosine %</b>
25	24	33	18

**Table 2**

(i) Describe how the ratios of the different bases in this virus differ from those in **Table 1**.

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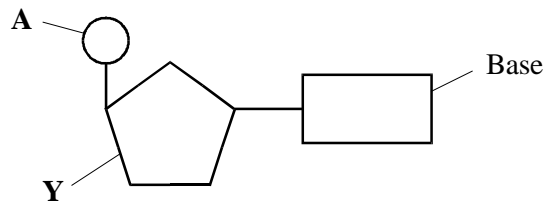
**(1)**

- (ii) The structure of the DNA in this virus is not the same as DNA in other organisms. Suggest what this difference in DNA structure might be.

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(1)  
(Total 8 marks)

3. (a) The diagram shows the structure of a DNA nucleotide.



Name the parts of the nucleotide labelled **X** and **Y**.

**X** .....

**Y** .....

(2)

- (b) The table shows the percentage composition of bases in the DNA of cattle and octopus.

<b>Organism</b>	<b>Adenine</b>	<b>Cytosine</b>	<b>Guanine</b>	<b>Thymine</b>
Cattle	29		21	
Octopus	33			33

- (i) Use your knowledge of the structure of DNA to calculate the missing values and complete the table

(1)



(ii) Explain your answer.

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(2)  
(Total 5 marks)

4. The drawing shows the chromosomes from a cell during meiosis.



(a) Name the phase of meiosis shown in the drawing. Give evidence for your answer.

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(2)

(b) What is the haploid chromosome number in this species?

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(1)

- (c) At the time shown in the diagram, this cell contained 8 picograms of DNA. How much DNA would be present in each gamete produced from this cell?

..... picograms.

(1)

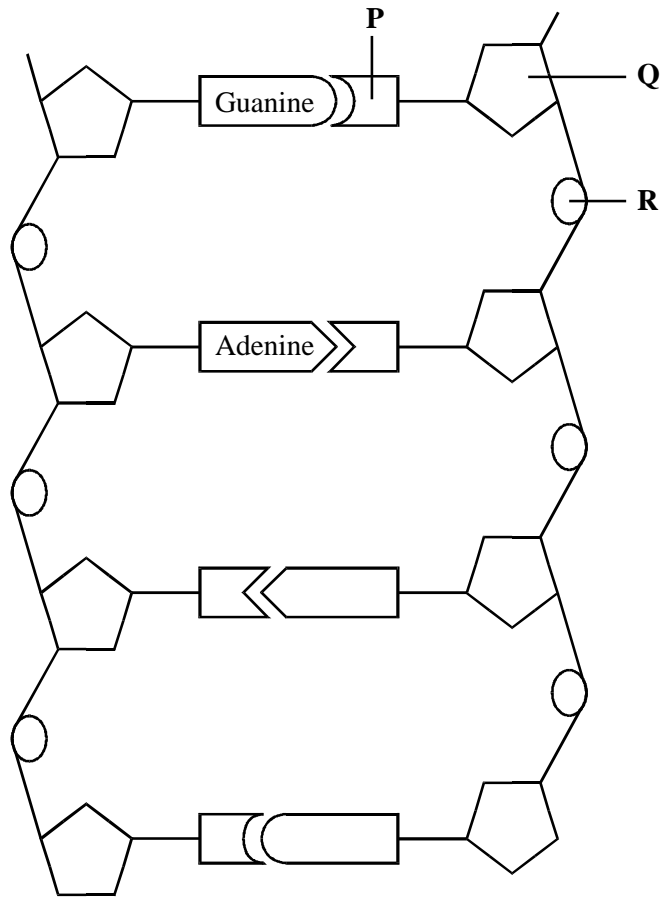
(d) In gamete production, what is the advantage of changing diploid cells into haploid cells?

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(1)

(Total 5 marks)

5. The diagram shows a section of a DNA molecule.



(a) Name parts **P**, **Q** and **R**.

**P** .....

**Q** .....

**R** .....

(2)



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

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(2)

- (c) A piece of DNA was analysed. 15% of its nucleotides were found to contain guanine. What percentage of its nucleotides would you expect to contain adenine? Show your working.

Answer .....

(2)

**(Total 6 marks)**

6. (a) The table shows the mass of DNA in various cells from the body of a man.

Cell	Mass of DNA / arbitrary units	Number of chromosomes
A	7	
B	14	46
C	28	

(i) Which cell is a mature sperm cell? Explain your answer.

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**(1)**

(ii) What would be the mass of DNA in a zygote resulting from the fertilisation of an egg cell by this sperm cell? Explain your answer.

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(2)

(b) What is the role of the spindle during the process of mitosis?

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(1)

(Total 4 marks)

7. Scientists believe that the tendency to develop cancer can be inherited. It is thought that some people possess cancer-causing genes. These genes only become functional when activated by an environmental factor. The functional genes then cause the production of abnormal cells. The abnormal cells multiply and spread, causing cancer.

- (a) Explain why medical screening of people for the presence of these cancer-causing genes is recommended.

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(2)



- (b) Cells also contain suppressor genes, which code for proteins that control cell division and growth. Describe what is meant by a mutation, and explain how a mutation in a suppressor gene might lead to the development of a malignant tumour.

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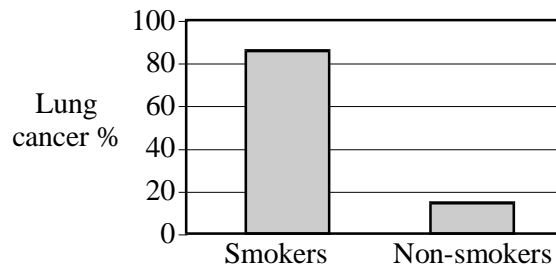
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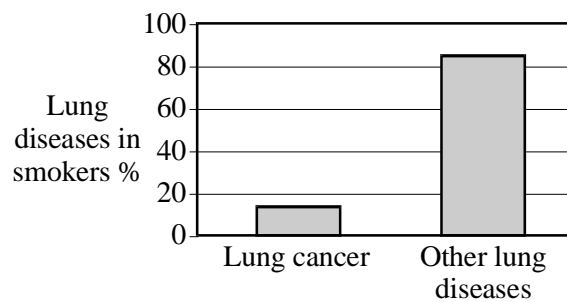
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(6)

- (c) **Figure 1** and **Figure 2** show information from one study of lung cancer and lung diseases in adults of all ages in the UK.



**Figure 1 – Proportion of lung cancer sufferers who are smokers or non-smokers.**



**Figure 2 – Proportion of types of lung disease in smokers who are suffering from lung disease.**

- (i) Give **three** conclusions that can be drawn from the results of this study.

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2 .....

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3 .....

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(3)

(ii) Suggest **two** reasons why conclusions, made only on the basis of these data, may not be reliable.

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

(2)

(d) Some scientists believe that heart disease is also the result of the activation of genes by environmental factors. One research study, to try and identify the genes responsible, was carried out on the people living on a remote island. Suggest why a remote island is more suitable for genetic research than an area like the UK.

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- .....
- .....
- .....

(2)

(Total 15 marks)

8. (a) (i) List the following phases of the cell cycle in the correct sequence.

**anaphase                  interphase                  metaphase                  prophase                  telophase**

- 1    interphase
- 2    .....
- 3    .....
- 4    .....
- 5    .....

(1)

(ii) During which phase does the replication of DNA occur?

- .....

(1)

- (b) Draw a single chromosome attached to a spindle fibre as it would appear during metaphase of mitosis. Label the following on your drawing:

**centromere**

**chromatid**

**spindle fibre**

(3)

- (c) The diploid chromosome number of the fruit fly is 8. How many chromosomes would be present in the nucleus of

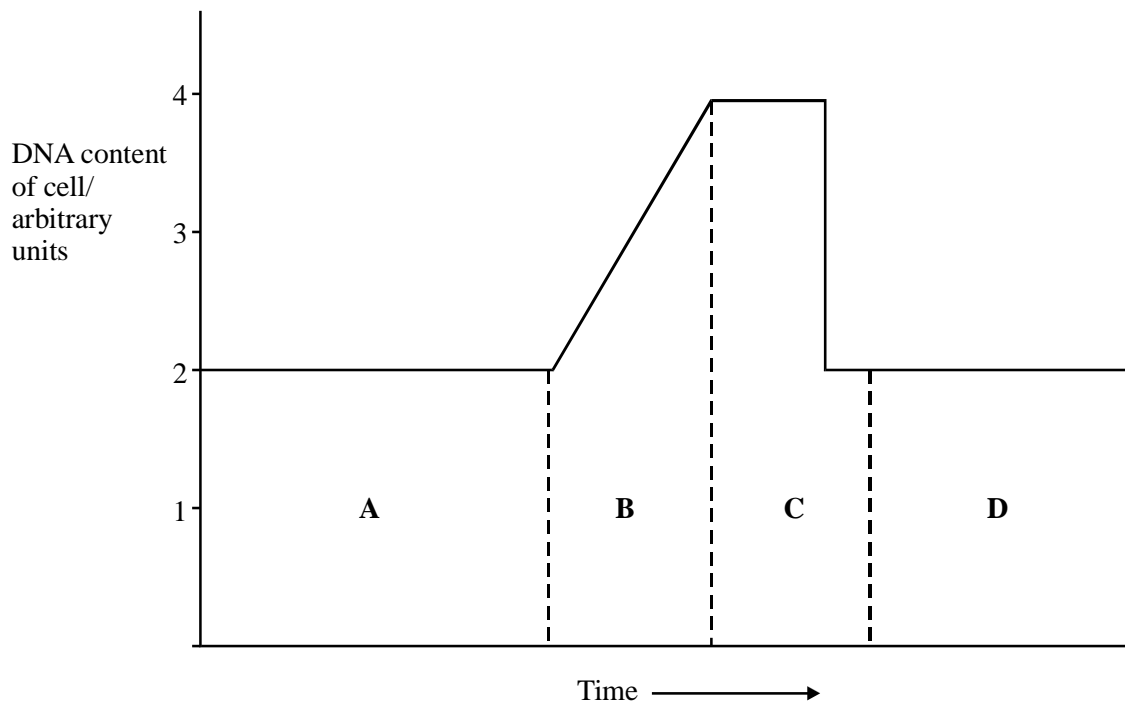
(i) a cell from the gut lining; .....

(ii) a sperm cell? .....

(1)

**(Total 6 marks)**

9. The graph shows the changes in the DNA content of cells during the cell cycle.



(a) In which of the stages, **A** to **D**, does each of the following take place?

(i) DNA replicates .....

(ii) The chromosomes become visible. ....

(2)

(b) Describe and explain how the amount of DNA in the cell changes during stage **C**.

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(3)

- (c) (i) Cytarabine is a drug used to treat cancer. It inhibits an enzyme needed to synthesise new DNA. Suggest how the graph would be different if cytarabine was present during the cell cycle.

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(1)

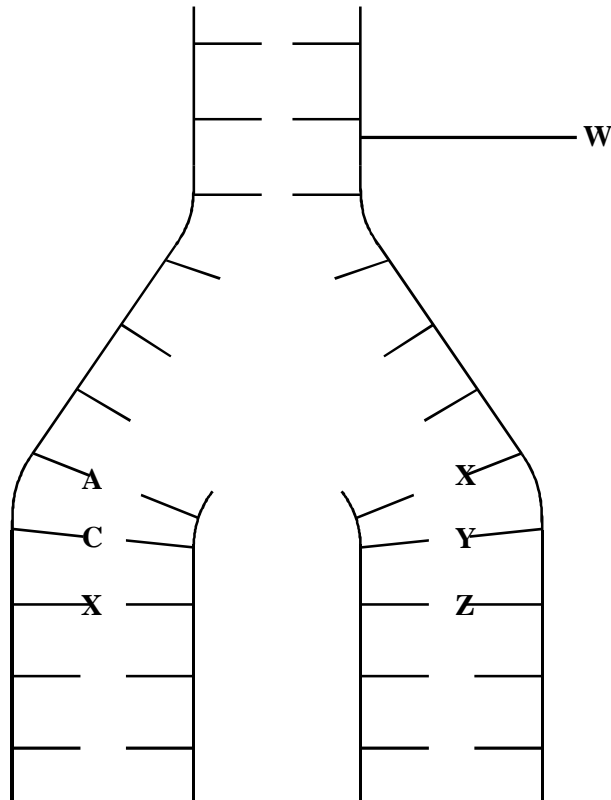
- (ii) Explain why cytarabine is effective in treating cancer.

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(2)

**(Total 8 marks)**

10. The diagram shows the process of DNA replication. The horizontal lines represent the positions of bases.



- (i) What is represented by the part of the DNA molecule labelled **W**?

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(1)

- (ii) In the diagram, **A** represents adenine and **C** represents cytosine.  
Name the base found at

position **X**; .....

position **Y**; .....

position **Z**. .....

(3)

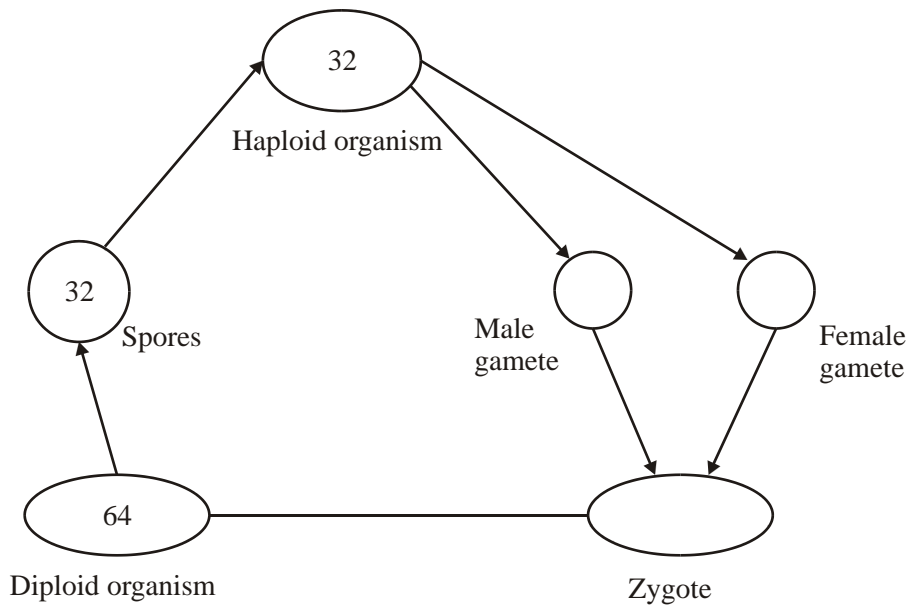
(Total 4 marks)

11. (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.

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(1)

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

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(1)

(Total 7 marks)

12. (a) Nucleic acids, such as DNA, are polymers, made up of many repeating monomer units. Name the monomer from which nucleic acids are made.

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(1)

(b) The table shows the percentage of different bases in the DNA of some organisms.

Organism	Percentage of each base			
	Adenine	Guanine	Cytosine	Thymine
Human	31.2	18.8	18.8	31.2
Cow	27.9	22.1	22.1	27.9
Salmon	29.4	20.6	20.6	29.4
Rat	28.6			
Virus	24.7	24.1	18.5	32.7

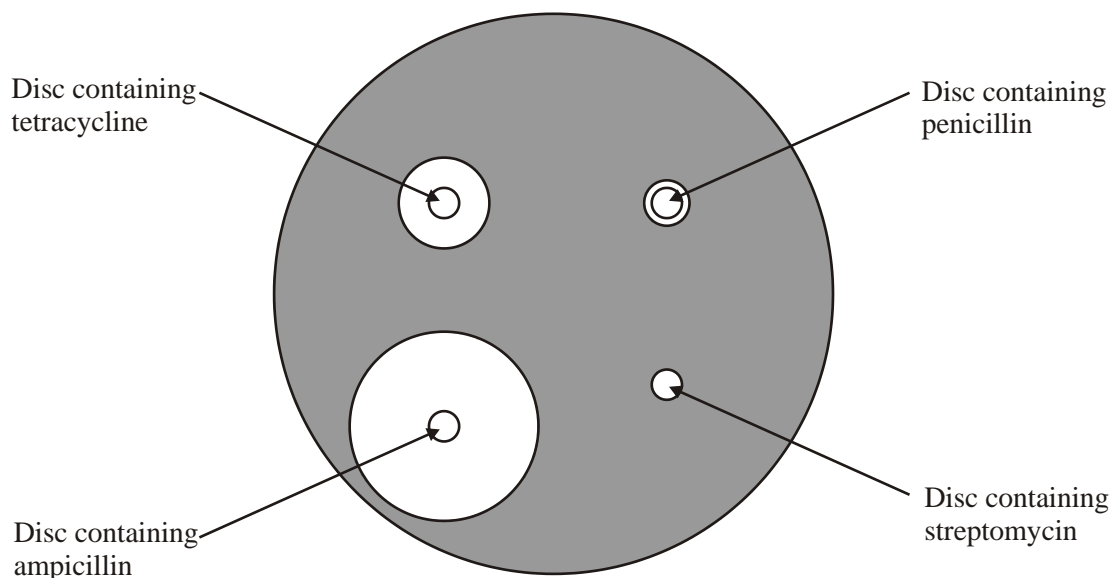
(i) Calculate the missing figures for rat DNA and write them into the table. (2)

(ii) The virus has single-stranded DNA as its genetic material. Explain the evidence from the table which suggests that the DNA is single-stranded.

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(2)  
(Total 5 marks)

13. In a hospital laboratory, a sterile Petri dish of nutrient agar was inoculated with bacteria from a patient with a throat infection. Four discs, each of which had been soaked in a different antibiotic, were placed on top of the bacteria. The dish was incubated at 37°C. **Figure 1** shows the appearance of the dish after incubation.



**Figure 1**

(a) Explain why there are clear zones around some of the discs containing antibiotic.

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(2)

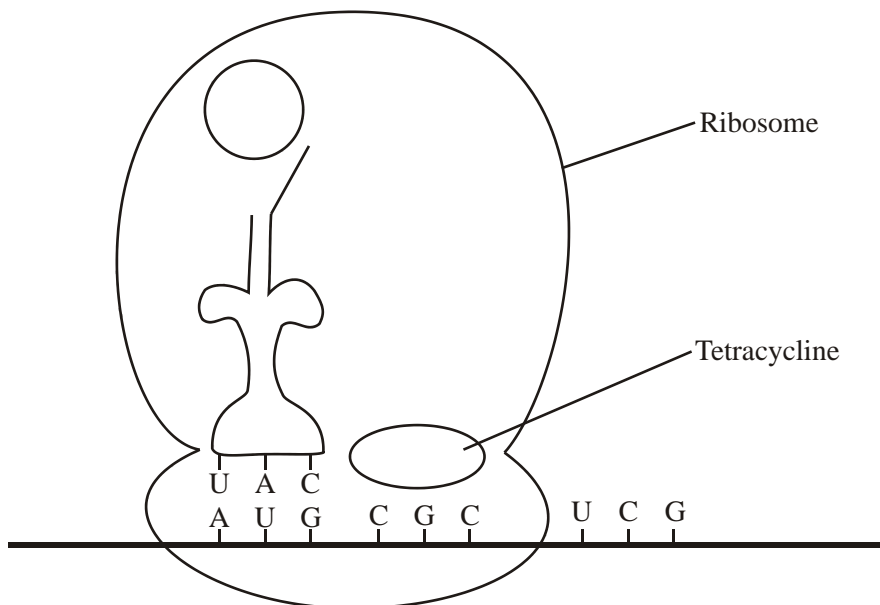
(b) It was suggested that ampicillin might be the best antibiotic to treat the patient's throat infection. Give the evidence from the laboratory test to support this suggestion.

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(1)

(c) Tetracycline binds to bacterial ribosomes. This is shown in **Figure 2**.



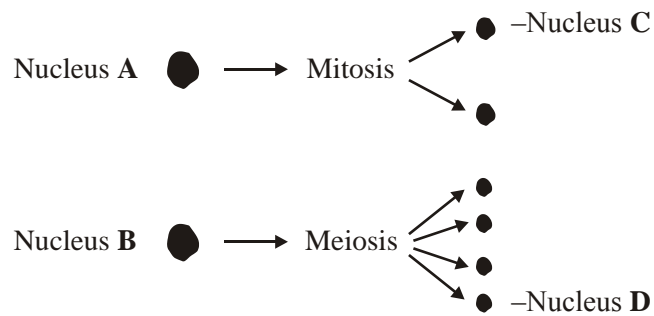
**Figure 2**

Tetracycline prevents bacterial growth by preventing protein synthesis. Give **two** other ways in which antibiotics can prevent bacterial growth.

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

(2)  
(Total 5 marks)

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



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

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

(2)

(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.

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(1)

(ii) Explain why a stain was used.

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(1)

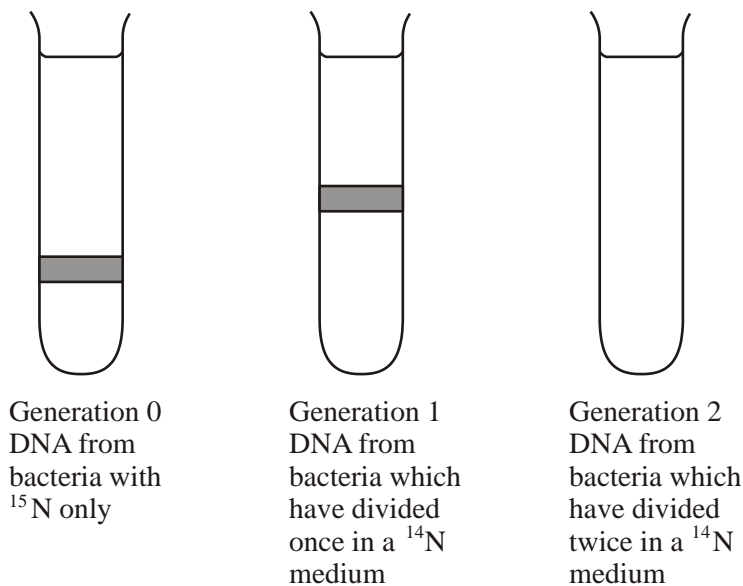
(Total 4 marks)

15. (a) There are two forms of nitrogen. These different forms are called isotopes.  $^{15}\text{N}$  is a heavier isotope than the normal isotope  $^{14}\text{N}$ .

In an investigation, a culture of bacteria was obtained in which all the nitrogen in the DNA was of the  $^{15}\text{N}$  form. The bacteria (generation 0) were transferred to a medium containing only the normal isotope,  $^{14}\text{N}$ , and allowed to divide once. A sample of these bacteria (generation 1) was then removed. The DNA in the bacteria of generation 1 was extracted and spun in a high-speed centrifuge.

The bacteria in the  $^{14}\text{N}$  medium were allowed to divide one more time. The DNA was also extracted from these bacteria (generation 2) and spun in a high speed centrifuge.

The diagram shows the results of this investigation.



(i) Which part of the DNA molecule contains nitrogen?

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(1)

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

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(2)

(iii) Complete the diagram to show the results for generation 2.

(2)

(b) The table shows the percentage of different bases in the DNA of different organisms.

Organism	Adenine%	Guanine%	Thymine%	Cytosine%
Human		19		
Bacterium	24	26	24	26
Virus	25	24	33	18

(i) Complete the table to show the percentages of different bases in human DNA.

(2)

(ii) The structure of virus DNA is different from the DNA of the other two organisms. Giving evidence from the table, suggest what this difference might be.

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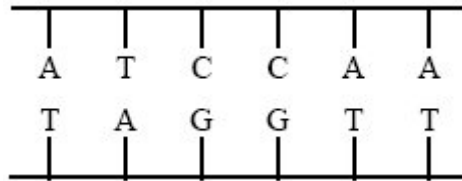
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(2)

(Total 9 marks)

16. (a) The diagram shows part of a DNA molecule. In the space below, draw a similar diagram to show this part of the molecule after it has replicated. Label the original strands and the new strands.



(2)

- (b) Biologists found the mean mass of DNA in three different types of cells from different animals. Their results are shown in the table.

Animal	Mass of DNA in nucleus/picograms		
	Liver cell	Blood cell	Sperm cell
Chicken	2.53	2.51	1.26
Goldfish	3.29	3.28	1.64
Trout	5.79	5.78	2.89
Toad	7.33	7.31	3.68

- (i) What would you expect to be the mean mass of DNA in a skin cell from a toad? Explain your answer.

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(2)

- (ii) A zygote is formed when a sperm cell fertilises an egg cell. How much DNA would you expect to find in a trout zygote that had just been formed? Explain your answer.

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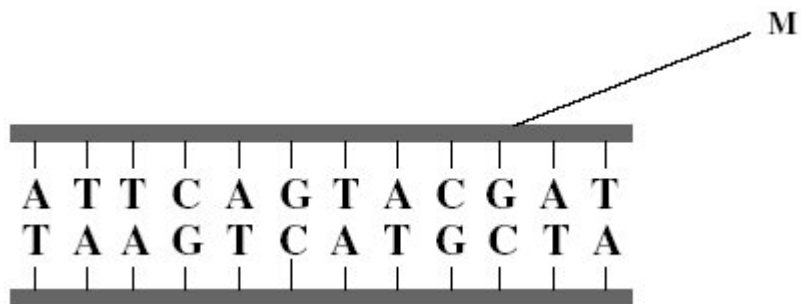
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(2)  
(Total 6 marks)

17. The diagram shows part of a DNA molecule.



- (a) Name the **two** components of the part of the DNA molecule labelled **M**.

1 .....

2 .....

(2)

- (b) What is the maximum number of amino acids for which this piece of DNA could code?

(1)



(c) Scientists calculated the percentage of different bases in the DNA from a species of bacterium. They found that 14% of the bases were guanine.

(i) What percentage of the bases in this species of bacterium was cytosine?

Answer ..... (1)

(ii) What percentage of the bases in this species of bacterium was adenine?

Answer ..... (1)

(d) The scientists found that, in a second species of bacterium, 29% of the bases were guanine.

Explain the difference in the percentage of guanine bases in the two species of bacterium.

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(2)  
**(Total 7 marks)**