

5 Meselson and Stahl provided data that supported the theory that DNA replicates by semi-conservative replication.

(a) State the meaning of the term semi-conservative replication.

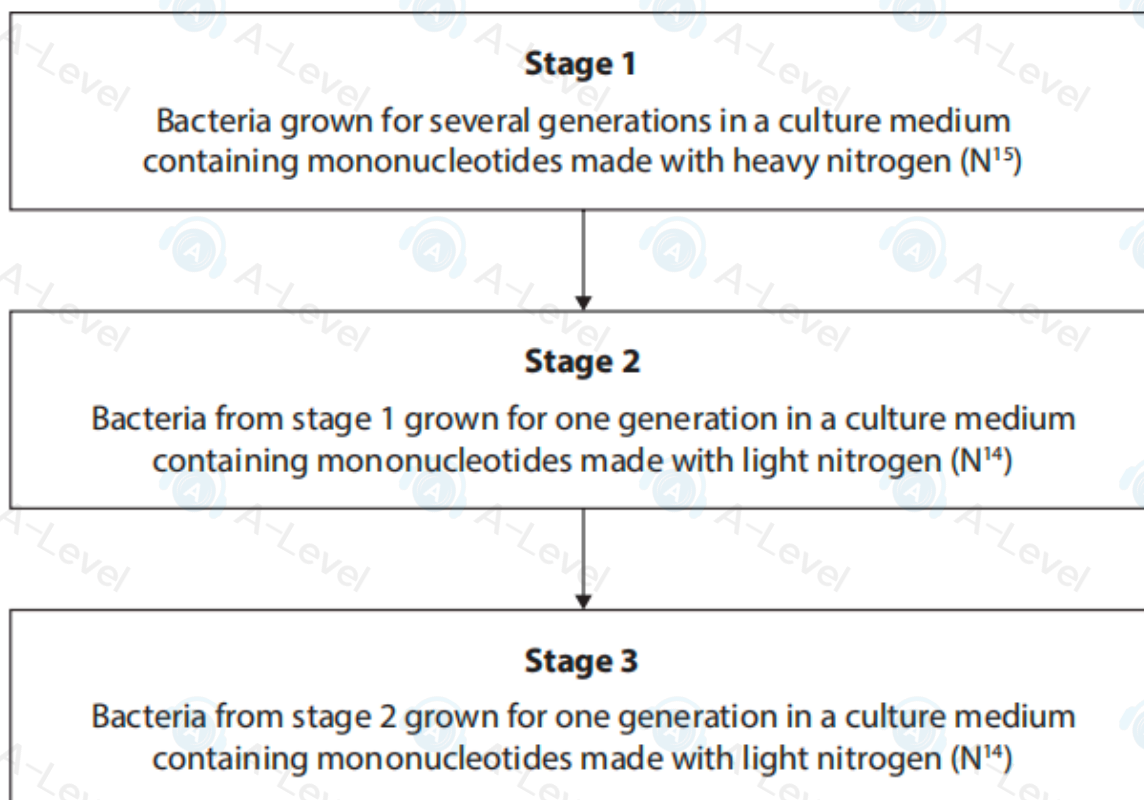
(2)

(b) Describe the role of DNA polymerase in the process of DNA replication.

(2)

- (c) Meselson and Stahl used mononucleotides made with either heavy nitrogen (N^{15}) or light nitrogen (N^{14}) in their experiments.

The flowchart summarises part of one experiment performed by Meselson and Stahl.

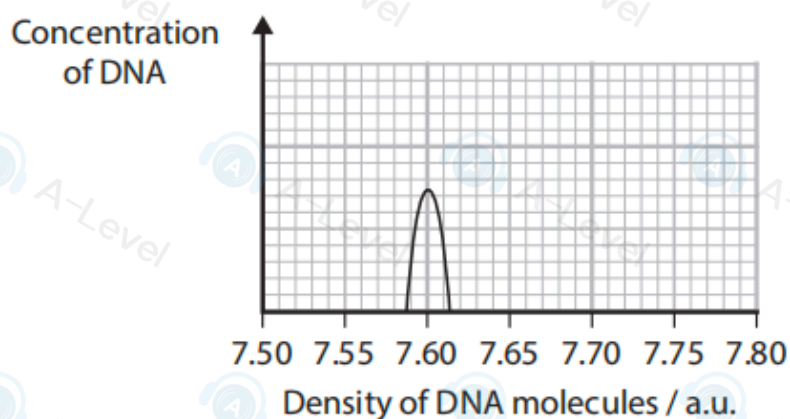


After each stage, a sample of DNA was taken from the bacteria and the DNA molecules separated on a density gradient in a tube.

- DNA with only heavy nitrogen has a mean density of 7.74 a.u.
- DNA with only light nitrogen has a mean density of 7.60 a.u.

Meselson and Stahl measured the concentration of DNA with different densities.

The graph shows the results of these measurements for DNA molecules with only light nitrogen.

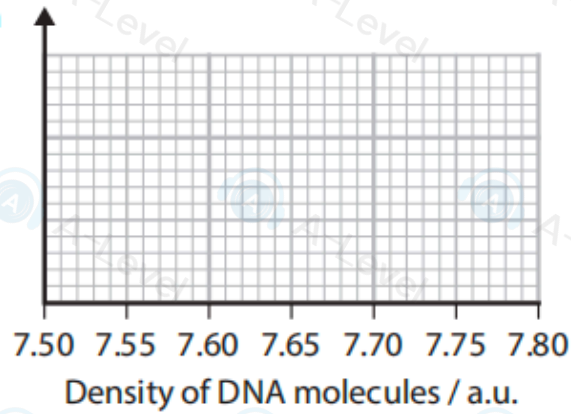


Complete the graphs to show the concentrations and densities of the DNA molecules produced at the end of stages 1, 2 and 3 shown in the flowchart.

(6)

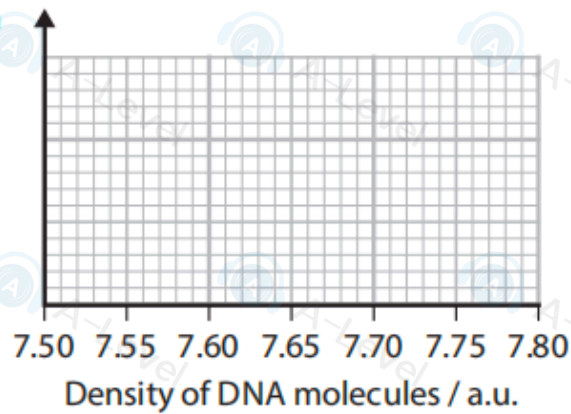
End of stage 1:

Concentration
of DNA



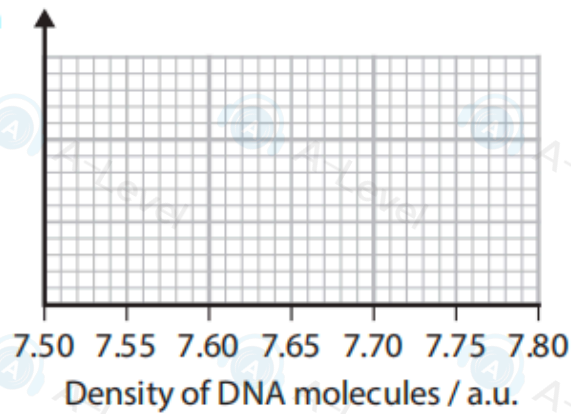
End of stage 2:

Concentration
of DNA



End of stage 3:

Concentration
of DNA



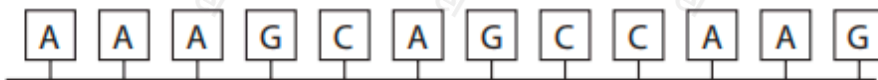
(Total for Question 5 = 10 marks)

- 2 The nature of the genetic code of a gene is important in determining the sequence of amino acids in a polypeptide chain.

The diagrams show the genetic code for some amino acids and the sequence of bases in part of a gene.

Genetic code	Amino acid	Genetic code	Amino acid	Genetic code	Amino acid	Genetic code	Amino acid
AAA AAG	Lysine	CAA CAG	Glutamine	GAA GAG	Glutamic acid	TAC TAT	Tyrosine
AAC AAT	Asparagine	CAT CAC	Histidine	GAC GAT	Aspartate	TCA TCC TCG TCT	Serine
ACA ACC ACG ACT	Threonine	CCA CCC CCG CCT	Proline	GCA GCC GCG GCT	Alanine	TGG	Tryptophan

Part of a gene:



The genetic code is described as a triplet code that is non-overlapping and is degenerate.

Explain what each of these phrases means.

Use the information provided to illustrate your answer.

(a) Triplet code

(2)

(b) Non-overlapping code

(2)

(c) Degenerate code

(2)

(Total for Question 2 = 6 marks)

(b) The DNA of the bacterium *E. coli* has a mass of 3.1×10^9 daltons (Da) and consists of 4.7×10^6 base pairs.

(i) Calculate the mean mass of a base pair.

Express your answer in standard form.

(1)

Answer Da

(ii) Calculate the total mass of DNA produced after three cell divisions.

Give your answer in grams, where 1 dalton = 1.67×10^{-24} grams.

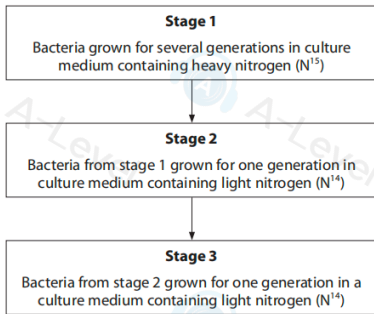
(2)

Answer g

(c) Meselson and Stahl provided data that supported the theory that DNA replicates by semi-conservative replication and disproved competing theories.

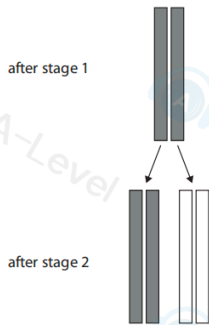
Heavy nitrogen (N^{15}) and light nitrogen (N^{14}) were used in their experiments.

The flow chart summarises part of one experiment performed by Meselson and Stahl.



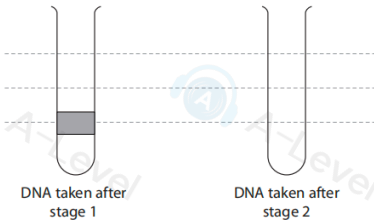
(ii) One competing theory was the conservative theory.

The diagram shows the conservative theory for the replication of DNA.



Complete the diagram to show the position of the bands on the density gradient in a tube if this was the correct theory.

(2)



After each stage, a sample of DNA was taken from the bacteria and the DNA molecules separated on a density gradient in a tube.

The heavier DNA molecules form bands lower down the gradient than the lighter DNA molecules.

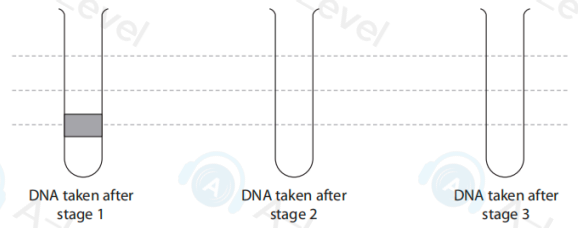
The width of each band is proportional to the percentage of molecules in the sample.

(i) Complete the diagram to show the results of this investigation.

Use the dotted lines to help you position the bands on the diagram.

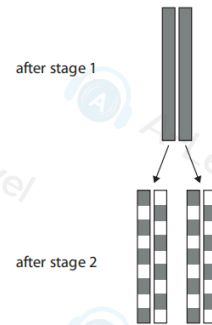
The first one has been done for you.

(3)



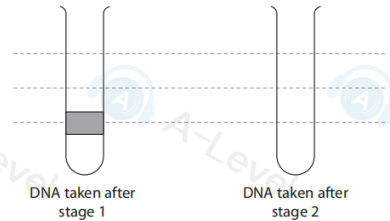
(iii) Another competing theory was the dispersive theory.

The diagram shows the dispersive theory.



Complete the diagram to show the position of the bands on the density gradient in a tube if this was the correct theory.

(2)



(Total for Question 8 = 13 marks)

TOTAL FOR PAPER = 80 MARKS

3 Whales are large mammals.

The photograph shows a beluga whale and a human diver.



(Source: © Andrey Nekrasov/Alamy Stock Photo)

(a) (i) A beluga whale can become habituated to human divers.

How many of the following statements about habituation are correct?

(1)

- habituation is an example of anatomical adaptation
- habituation is only observed in mammals
- habituation only occurs after repeated exposure to the same stimulus

A 0

B 1

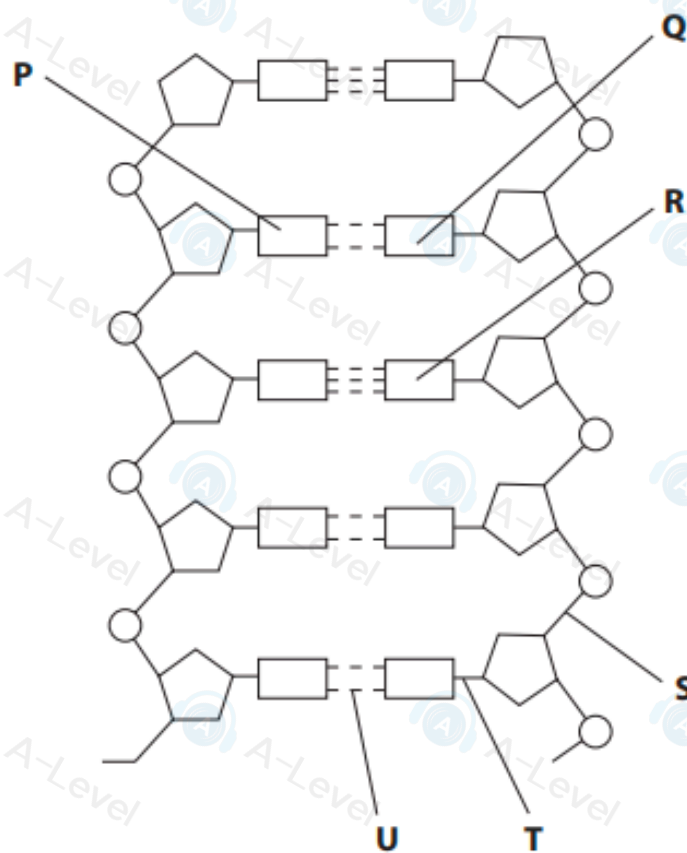
C 2

D 3

4 The polynucleotide DNA is composed of mononucleotides linked together.

Two polynucleotides form a DNA molecule.

(a) The diagram shows part of a DNA molecule.



(i) Draw a circle around **one** mononucleotide that includes the base labelled **R**.

(1)

(ii) Which row of the table identifies the bonds labelled **S**, **T** and **U**?

	S	T	U
<input type="checkbox"/> A	hydrogen	phosphodiester	covalent
<input type="checkbox"/> B	hydrogen	covalent	phosphodiester
<input type="checkbox"/> C	phosphodiester	hydrogen	covalent
<input type="checkbox"/> D	phosphodiester	covalent	hydrogen

(iii) The base labelled **P** is adenine.

Which is the base labelled **Q**?

- A** cytosine
- B** guanine
- C** thymine
- D** uracil

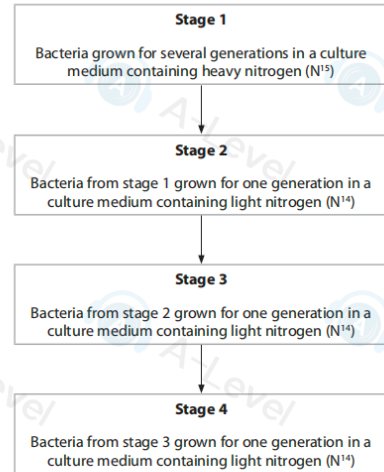
(1)

(1)

(b) Meselson and Stahl carried out experiments that provided evidence for the semi-conservative replication of DNA.

Heavy nitrogen (N^{15}) and light nitrogen (N^{14}) were used in these experiments.

The flow chart summarises part of one experiment performed by Meselson and Stahl.



After each stage, a sample of DNA was taken from the bacteria and the DNA molecules separated using a density gradient in a tube.

The heavier DNA molecules form bands lower down the gradient than the lighter DNA molecules.

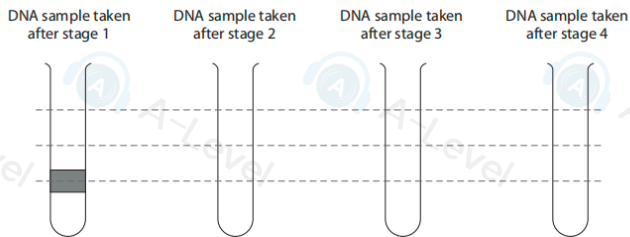
The height of each band is proportional to the percentage of DNA molecules in the sample.

(i) Complete the diagram to show the results of this experiment.

Use the dotted lines to help you to position the bands on the diagram.

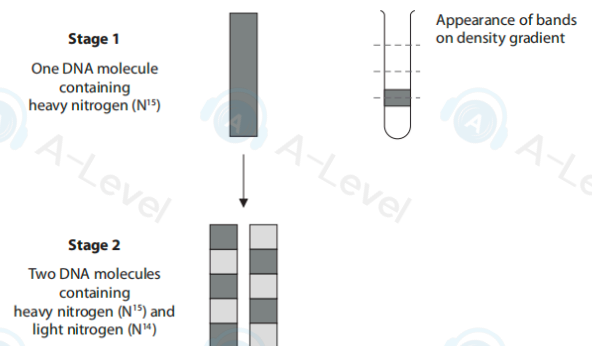
The first one has been done for you.

(5)



(ii) The experiments of Meselson and Stahl disproved the dispersive theory of DNA replication.

The diagram shows the expected results if the dispersive theory was correct.



Which diagram would show the bands of DNA molecules on the density gradient at stage 2, if the dispersive theory was correct?

(1)

- A**
- B**
- C**
- D**

(Total for Question 4 = 9 marks)