

Nucleotides & Nucleic Acids

Question Paper 1

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Foundations in Biology
Topic	Nucleotides & Nucleic Acids
Booklet	Question Paper 1

Time allowed: 62 minutes

Score: /46

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E
>69%	56%	50%	42%	34%	26%

Question 1

Fig. 24 shows a DNA nucleotide.

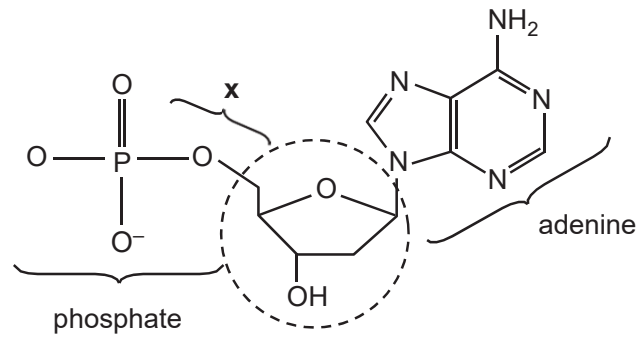


Fig. 24

(a) (i) Name the circled component in Fig. 24. **[1]**

(ii) Name the bond labelled **x** in Fig. 24. **[1]**

(b) Identify two similarities and two differences between the DNA nucleotide shown in Fig. 24 and a molecule of ATP. **[4]**

Similarities

Differences

[Total: 6]

Question 2

Semi-conservative replication describes the process by which DNA is replicated in all living organisms.

(a) (i) Explain the meaning of the phrase *semi-conservative replication*. [1]

(ii) DNA ligase is one enzyme involved in the replication of DNA.

State **two** other enzymes involved and describe their functions. [4]

- (b) In 1958, Matthew Meselson and Franklin Stahl carried out an experiment that provided evidence to support the hypothesis of semi-conservative replication of DNA.

Meselson and Stahl grew *E. coli* bacteria in a growth medium that contained only the heavy isotope of nitrogen ^{15}N . They transferred the bacteria to a growth medium that had the light ^{14}N isotope and allowed the bacteria to undergo cell division.

After each division, the DNA from some of the bacteria was extracted from the culture and centrifuged to separate it. Fig. 25 shows the bands of DNA in the centrifuge tubes after a specific number of divisions.

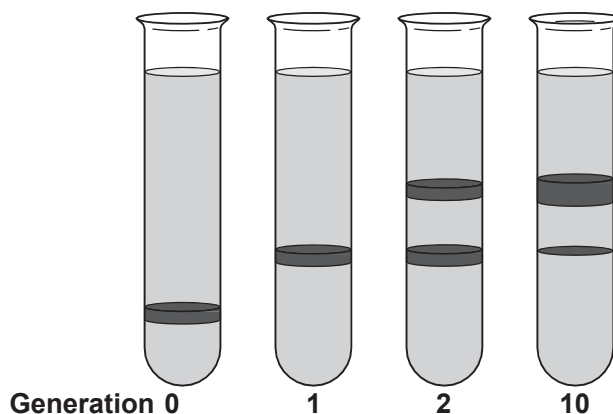


Fig. 25

The tube labelled **Generation 0** in Fig. 25 shows a single band of DNA containing bases that contain only the heavy isotope of nitrogen ^{15}N .

Explain how the results from the other generations provide evidence to support the hypothesis that DNA replication is semi-conservative. [2]

[Total: 7]

Question 3

Even the smallest DNA molecules are very long.

- A kilobase (Kb) is a unit equivalent to 1000 base pairs of a DNA molecule.
- One Kb of double stranded DNA has a length of $0.34 \mu\text{m}$.

(a) The DNA in the nucleus of a cell from a fruit fly (*Drosophila*) is 5.6 cm long.

- (i) Calculate the number of Kb in the DNA of the fruit fly.
Show your working. Give your answer to the nearest whole number. [2]

- (ii) The DNA of the fruit fly was analysed and 22% of the bases were adenine.
What % of the bases were guanine? Show your working. [2]

(b) A DNA molecule contains polynucleotide strands.

- (i) Individual nucleotides are joined together to make a polynucleotide strand.
What type of chemical reaction takes place when two nucleotides in a single polynucleotide strand are joined together? [1]

- (ii) Name the chemical released when the bond is formed between the two nucleotides. [1]

- (iii) A DNA molecule contains two polynucleotide chains.
Describe how these two chains are held together. [3]

[Total: 9]

Question 4

DNA is arguably the most important molecule in the whole of biology.

When a cell divides an identical copy of its DNA is made in a process called DNA replication.

(a) Explain how pairing of nitrogenous bases allows identical copies of DNA to be made. [3]

(b) (i) Outline how the process of DNA replication is completed, following the pairing of nitrogenous bases. [3]

(ii) Why is DNA replication described as semi-conservative? [1]

[Total: 7]

Question 5

(a) Fig. 5.1 shows part of a DNA molecule.

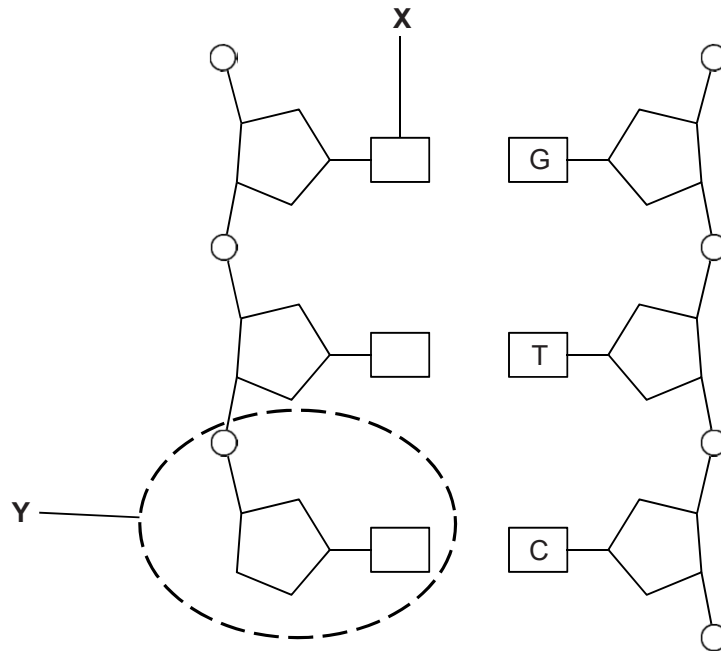


Fig. 5.1

(i) Name the parts of the molecule represented by the letters **X** and **Y**. [2]

(ii) Complete the diagram in Fig. 5.1 by drawing hydrogen bonds to connect the two strands.

The hydrogen bonds should be drawn on Fig. 5.1.

[2]

- (iii) Complete the following paragraph by using the most appropriate term(s).

A gene is a section of DNA that codes for the production of a

The molecule that copies a gene and carries the information to a

is called RNA.

[2]

- (iv) State **two** ways in which a diagram of part of an RNA molecule would appear different from the DNA molecule shown in Fig. 5.1.

[2]

(b) DNA replication takes place during interphase of the cell cycle. It occurs by a semi-conservative mechanism.

- (i) Explain why DNA replication is considered to be semi-conservative.

[2]

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

[2]

- (c) In 1958, two scientists, Meselson and Stahl, conducted an investigation into DNA replication.
- Bacteria were grown in a food source that contained only the 'heavy' isotope of nitrogen, ^{15}N . After many generations, the bacterial DNA contained only the 'heavy' form of nitrogen.
 - Some of the bacteria were then transferred to another food source containing only the normal, 'lighter' form of nitrogen, ^{14}N .
 - DNA was extracted from the bacteria and centrifuged. (When a solution is centrifuged, the heavier, more dense molecules tend to settle nearer the bottom of the tube.)

Some of the results from the experiment are shown in Fig. 5.2.

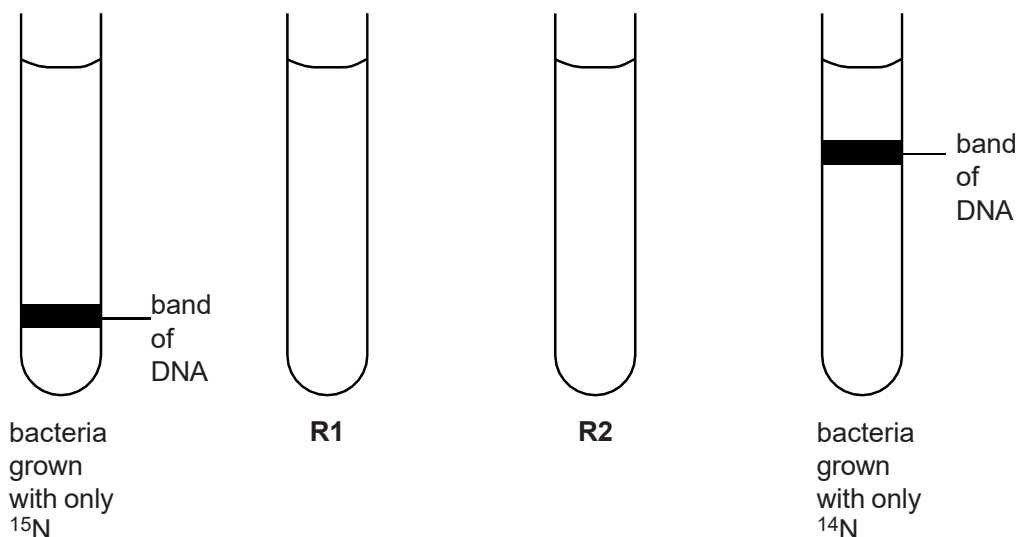


Fig. 5.2

- (i) In Fig. 5.2, the tube labelled **R1** represents the results for DNA extracted from bacteria that had been **transferred** from the ^{15}N to the ^{14}N food source and left long enough for their DNA to replicate **once** only.

Draw **one** band on tube **R1** in the position you would expect the DNA to appear **after** centrifuging.

Draw the band on Fig. 5.2.

[1]

- (ii) In Fig. 5.2, the tube labelled **R2** represents the results for DNA obtained from bacteria that had been **transferred** from the ^{15}N to the ^{14}N food source and left long enough for their DNA to replicate **twice**.

Draw **two** bands on tube **R2** in the positions you would expect the DNA to appear **after** centrifuging.

Draw the bands on Fig. 5.2.

[1]

(d) The technique of centrifugation used by Meselson and Stahl involves:

- mixing the DNA sample with concentrated sugar solution
- placing the mixture of DNA and sugar solution in test-tubes
- spinning the test-tubes at a very high speed.

Suggest **three** precautions that Meselson and Stahl would have taken in order to ensure that the centrifugation part of their investigation produced valid results.

[3]

[Total: 17]