1 Fig. 5.1 shows part of a DNA strand.

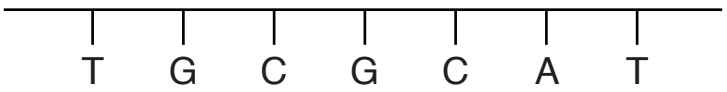

Fig. 5.1

(a) (i) Name the base represented by the letter **T**.

..... **[1]**

(ii) On Fig. 5.1, draw a section of the mRNA strand that is complementary to the section of the DNA strand shown.

..... *This should be answered on Fig. 5.1* .....**[2]**

(b) Table 5.1 contains a list of statements about DNA replication. Some of these statements are incorrect.

Put a cross (**X**) in the box next to each **incorrect** statement.

DNA replication	**Incorrect statement**
The DNA molecule unwinds	
Hydrogen bonds between the base pairs break	
Free RNA nucleotides join to bases on the exposed DNA strands	
Both polypeptide strands act as a template	
Hydrogen bonds form between complementary bases	
Three hydrogen bonds form between bases A and T	
DNA polymerase links the new nucleotides	
Covalent bonds form between the phosphate of one nucleotide and the pentose sugar of the next nucleotide	

[3]

Table 5.1

(c) Complete the following passage by using the most appropriate terms.

Variation can be described as the differences in characteristics between ..... . The type of variation that is caused by differences in DNA is known as ..... variation. Variation can also be caused by the ..... . Variation between members of the same species is known as ..... variation. Evolution depends on variation and ..... of the best adapted individuals. **[5]**

[Total: 11]

2 The genetic code carries instructions for the synthesis of polypeptides.

(a) (i) State the number of DNA nucleotide bases that code for a single amino acid.

..... **[1]**

(ii) There is a maximum of 64 different base combinations in DNA that could each code for an amino acid.

How is this number of combinations calculated?

.....

..... **[1]**

(iii) Twenty different amino acids are commonly used for protein synthesis. In theory, this would need only 20 different base combinations.

Explain the uses of the remaining 44 combinations.

.....

.....

.....

.....

..... **[2]**

(iv) Which nucleotide bases are common to DNA and RNA?

.....

..... **[1]**

(b) Describe how a nucleotide base sequence in a gene is used to synthesise a polypeptide.

In your answer you should describe the steps of the process in the correct order.

[7]

[Total: 12]

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

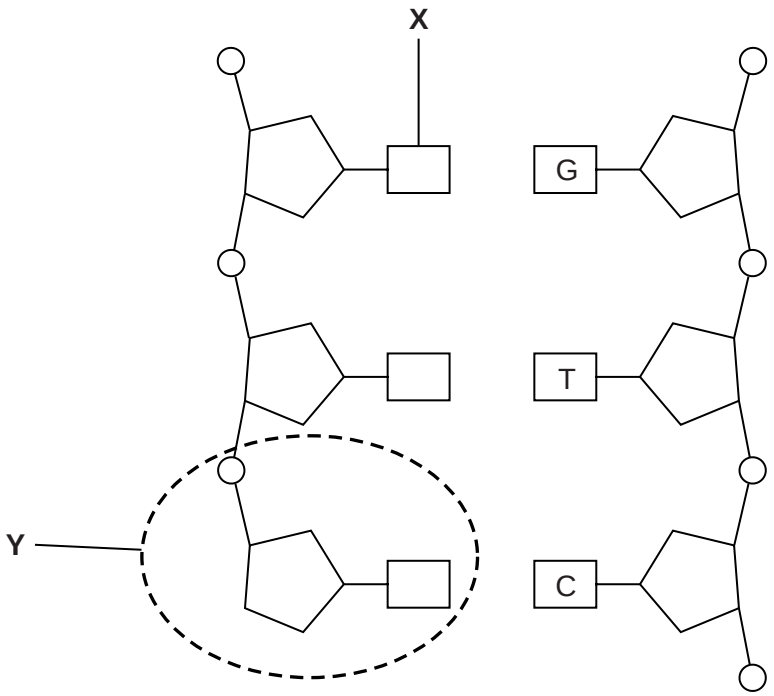

Fig. 5.1

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

X .....

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.

1 .....

.....

.....

2 .....

.....

.....

[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.

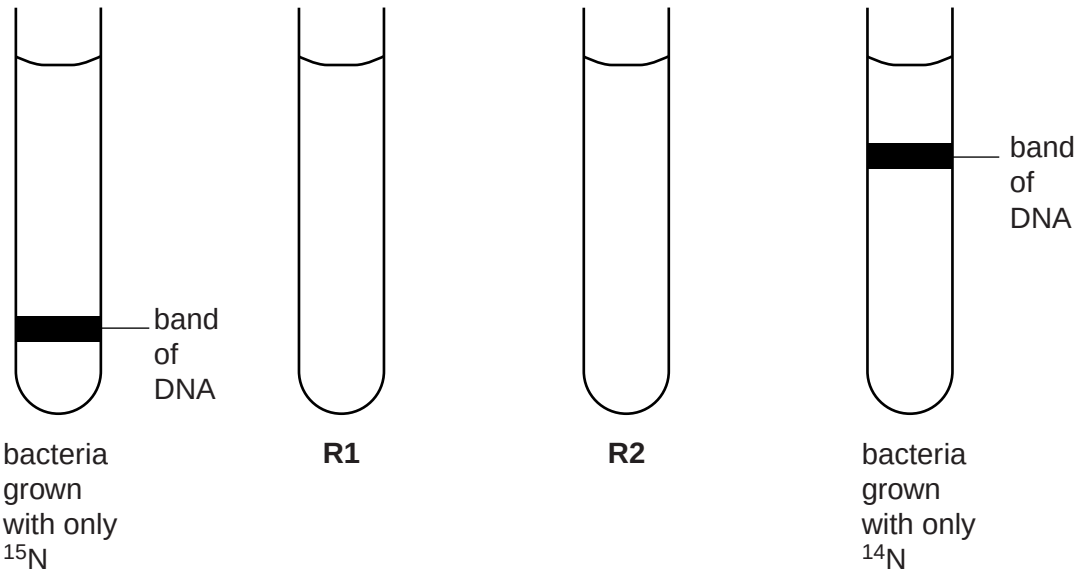

Fig. 5.2

(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.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

[Total: 17]

4 **(a)** Glucose is a hexose sugar and is a monomer in many carbohydrates.

Name the precise group of carbohydrate molecules of which glucose is an example.

..... **[1]**

(b) Fig. 6.1 represents the structure of a **β-glucose** molecule.

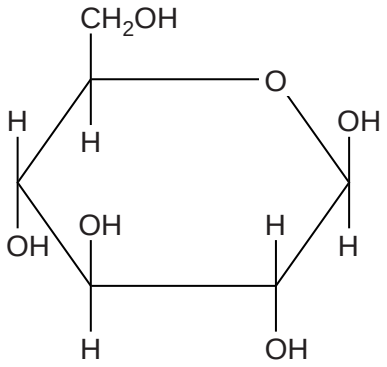

Fig. 6.1

(i) Use Fig. 6.1 to draw a similar representation of an **α-glucose** molecule in the space provided below.

[2]

(ii) The cells of living organisms require glucose.

State and explain **two** ways in which the glucose molecule is well suited to its function in living organisms.

.....

.....

.....

..... **[2]**

(c) Deoxyribose is a pentose sugar that is a component of the double-stranded DNA molecule.

Describe the structural relationship between deoxyribose and the other components of the DNA molecule.

.....

.....

.....

.....

.....

.....

..... **[3]**

(d) Cellulose is a carbohydrate.

A student described the structure of cellulose as follows:

> The cellulose molecule is insoluble.
> It contains only the elements carbon, hydrogen and oxygen.
> It is made up of α-glucose subunits.
> The glucose subunits are linked by 1-4 glycosidic bonds formed by hydrolysis reactions.
> It also has some 1-6 glycosidic bonds.
> It is made of many long chains.
> The chains have branches.

(i) Identify **three** mistakes made by the student when describing the structure of cellulose.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(ii) Suggest the name of a molecule that closely matches the student's description.

..... **[1]**

[Total: 12]