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# 11

# Molecular Genetics

## Structured Questions >>

### Level 1

1. Figure 11.1 shows a section of a deoxyribonucleic acid (DNA) molecule.

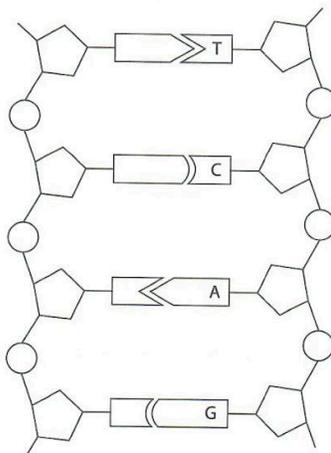


Figure 11.1

- Complete the diagram of the DNA molecule by adding the missing nitrogenous bases. [4]
- State **two** reasons for your answers in (a). [1]
- Two different sections of nucleotide sequence from two different genes are shown below:

Gene 1: TCA GAC TCG AGC

Gene 2: TTG GAC CAG AGC

- Define a *gene*. [1]
- Explain why Gene 1 and Gene 2 will result in different polypeptide chains. [2]

**Level 2**

2. Figure 11.2 shows a part of a DNA molecule.



Figure 11.2

- (a) State **three** components that make up the DNA molecule. [3]
- (b) Explain why DNA is also considered to be a polymer. [1]
- (c) On a bacterium DNA, researchers calculated the number of different bases and found 12% of the nitrogenous bases are thymine.  
Calculate the percentage of cytosine bases in this DNA molecule. Show your working clearly. [2]

**Level 3**

- 3. (a) Draw the structure of components that make up **one** nucleotide of DNA. Label the components. [1]
- (b) Table 11.1 shows the percentages of bases in the DNA of three different people for a specific gene.

Table 11.1

Name	Cytosine (C) %	Adenine (A) %	Thymine (T) %	Guanine (G) %
Mary	23			
John				24
Sally			28	

Complete Table 11.1 by filling in the blanks. [3]

4. Table 11.2 shows the percentages of bases found in a particular virus.

Table 11.2

Cytosine (C) %	Adenine (A) %	Thymine (T) %	Guanine (G) %
28	38	0	21

- (a) State whether the genetic material found in the virus is DNA. [1]
- (b) Explain your answer in (a)(i). [2]

5. A scientist created two new artificial nucleotides named U and V.  
 Figure 11.3 shows a segment of a gene containing the two new artificial nucleotides.

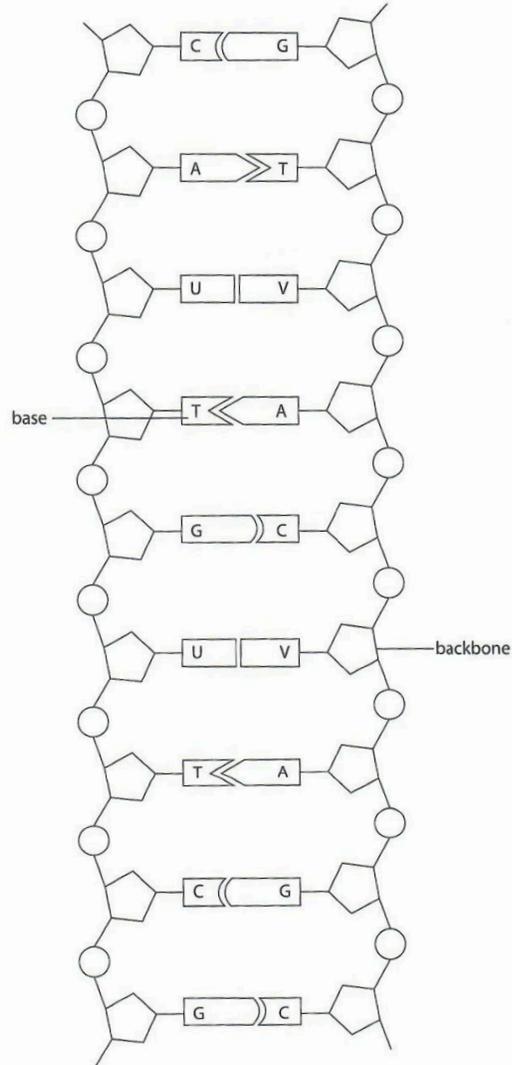


Figure 11.3

- (a) State the number of polypeptide chain(s) the gene had encoded for originally, prior to the substitution of the new artificial nucleotides. [1]
- (b) Creation and insertion of the two artificial nucleotides, U and V, led to more polypeptides than it originally encoded for. Explain why this is so. [2]

6. Figure 11.4 shows two of the first proposed structures of the DNA molecule before the current structure was recognised in 1953.

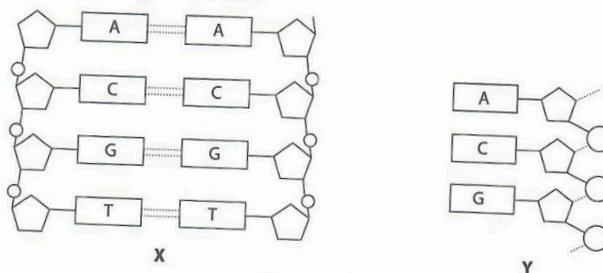


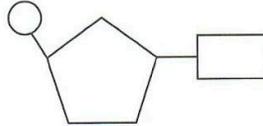
Figure 11.4

- (a) State what A, C, G and T shown in the structures represent. [4]
- (b) Explain why **X** and **Y** were rejected as structures of a DNA molecule. [2]
- (c) When DNA is hydrolysed and then tested with Benedict's solution, a brick-red precipitate is formed. [1]
- (i) Explain why this happens. [3]
- (ii) Suggest how the components and structure of a DNA differ from that of glucose.

**Free-response Questions** >>

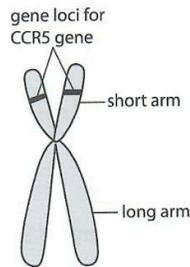
**Level 2**

7. Figure 11.5 is a diagram that shows the structure of a deoxyribonucleotide.



**Figure 11.5**

- (a) Describe the structure of a deoxyribonucleotide and how it contributes to the stability of the DNA molecule. [3]
- (b) During a genetic modification of the human genome, a gene called CCR5 which encodes a protein that allows the human immunodeficiency virus (HIV) to attach to cells, was deleted in human embryos. The CCR5 gene is located on the short arm of chromosome 3 as shown in Figure 11.6.



**Figure 11.6**

Distinguish between a *gene*, a *chromosome* and *DNA*. [3]

(c) Part of the sequence for both normal and modified gene is shown below:

Normal: GGC TGA GGA CTC

Modified: GGC TGA CTC

Using information given above, explain why the modified gene will give rise to a different protein and how this could help prevent HIV infection. [4]

**Level 3**

8. Deoxyribonucleic acid (DNA) is the macromolecule used to store genetic information.

- (a) Describe the structure of a DNA molecule. [3]  
 (b) Genes have the ability to spontaneously mutate.

Figure 11.7 shows the effect of mutation on DNA. Table 11.3 shows the DNA codons for three amino acids.

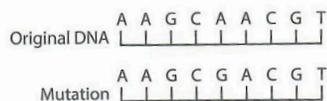


Figure 11.7

Table 11.3

Amino Acid	DNA Codon
valine	CAG
	CAA
	CAT
	CAC
alanine	CGT
	CGG
	CGA
cysteine	AAA
	AAG

- (i) State **two** causes of mutation. [2]  
 (ii) Explain how the mutation in Figure 11.7 may affect the polypeptide coded by this section of the gene. [3]

9. Table 11.4 shows the rate of protein synthesis of a human gene in a cell with temperature over time in a certain experiment.

Table 11.4

Temperature / °C	Rate of Reaction / Arbitrary Unit per Minute
0	1.5
10	4.0
20	8.0
30	19.0
40	33.0
50	28.5
60	16.5

- (a) Using the information given in Table 11.4, plot a suitable graph to reflect the rate of protein synthesis with increasing temperature. [3]
- (b) Explain the shape of the graph drawn in (b)(i). [3]
- (c) A student conducted an experiment to investigate the effect of temperature on the rate of protein synthesis in a cell. He removes the cytoplasm of the cell, leaving it with only a nucleus.
- (i) Predict the rate of protein synthesis in this cell. [1]
- (ii) Explain your answer in (c)(i). [2]