

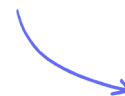
Structured Questions

Nucleic Acids

DNA & RNA Structure / Basis of Genetic Code / Nucleic Acid Structure & Function

Easy (3 questions)	/21
Medium (5 questions)	/24
Hard (4 questions)	/27
Total Marks	/72

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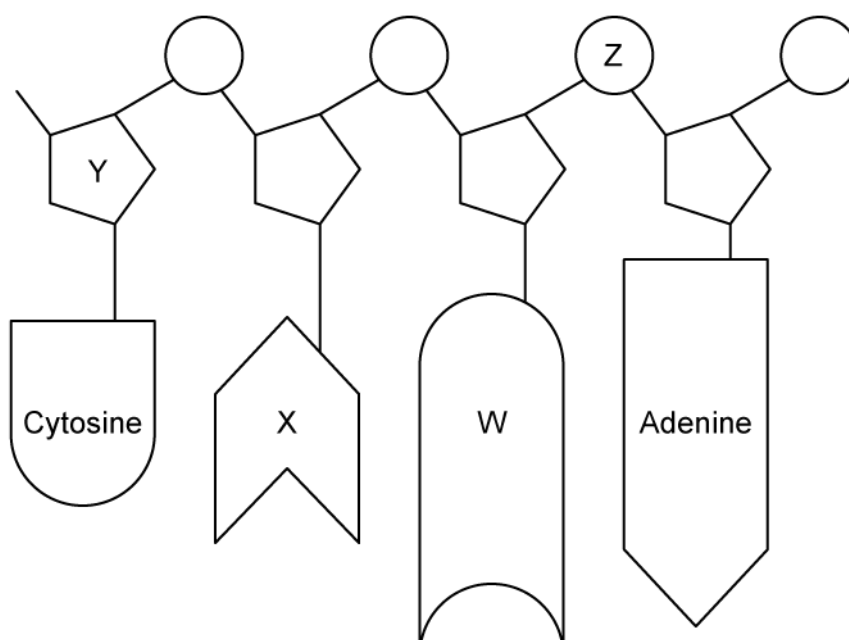


Easy Questions

1 (a) Describe the main role of DNA.

(2 marks)

(b) The image below shows a representation of several nucleotides in a molecule of DNA.



Identify the structures marked **Y** and **Z**.

(2 marks)

(c) DNA and RNA are referred to as polynucleotides.

State the meaning of the prefix '**poly**' in the term **polynucleotide**.

(1 mark)

2 (a) In a section of DNA 17 % of the nucleotides were found to contain cytosine.

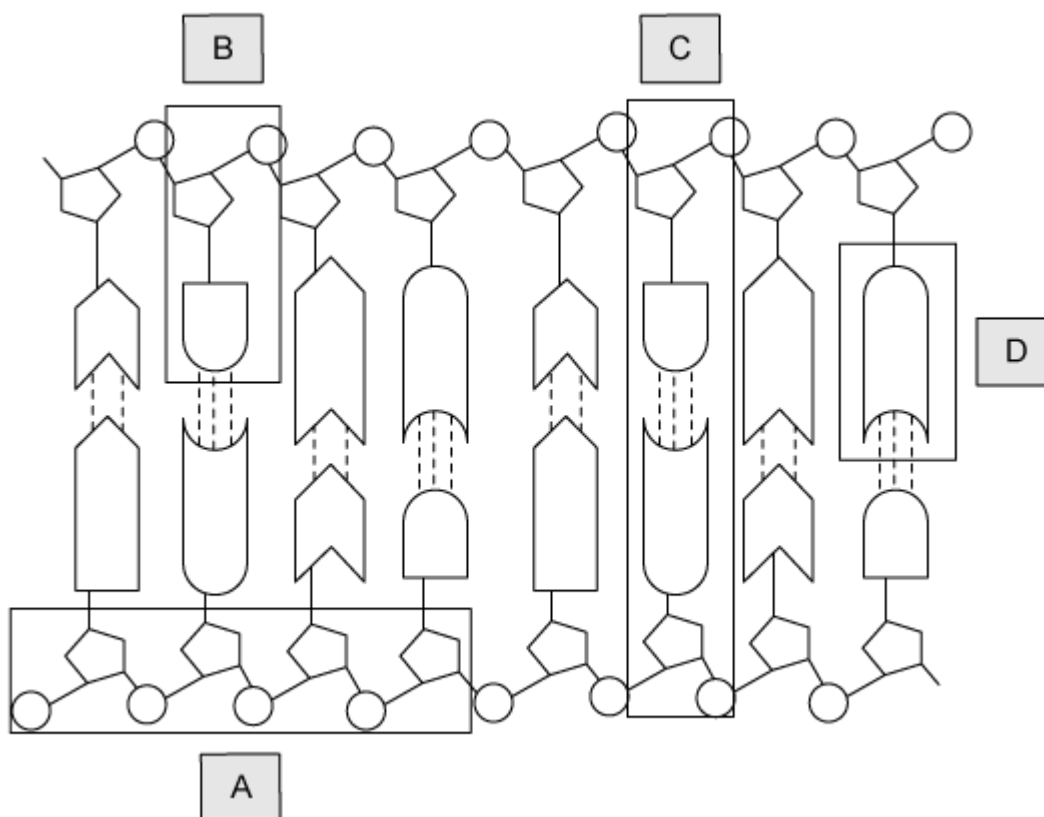
Calculate the percentage of thymine in this section of DNA.

(2 marks)

(b) State **one** reason why the calculation from part a) could not be performed for a piece of RNA.

(1 mark)

(c) The diagram below shows a representation of part of a DNA molecule.



Identify the structures labelled **A**, **B**, and **D**.

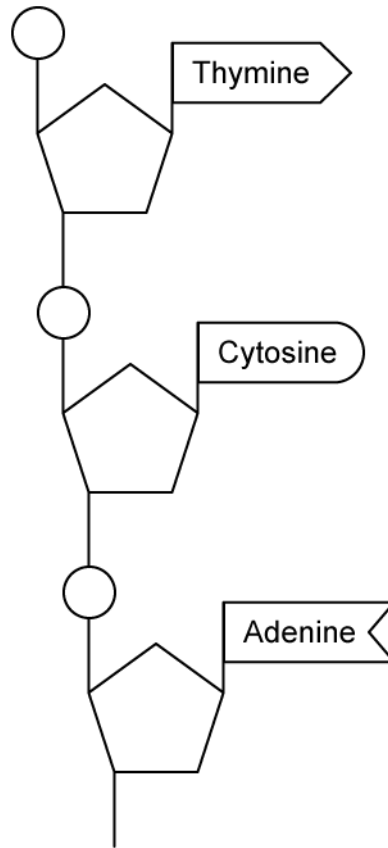
(3 marks)

(d) Identify **one** type of bond found within the structure labelled **C** in the diagram at part c).

(1 mark)

3 (a) One mark is available for clarity of communication throughout this question.

Draw on and annotate the diagram below to show the correct structure of double-stranded DNA.



(4 marks)

(b) Compare and contrast the structures of DNA and RNA.

(5 marks)

Medium Questions

1 (a) The 3D shape of DNA is known as a double helix.

State whether it is possible for a strand of RNA to form a double helix.

(1 mark)

(b) State the part of a DNA molecule that contains nitrogen.

(1 mark)

- 2 (a) Using appropriate shapes to represent chemical structures, draw **and** label a single RNA nucleotide.

(2 marks)

- (b) A section of DNA was found to contain the following percentages of bases, as shown in the table below.

	%			
	Adenine	Cytosine	Guanine	Thymine
Sense strand	15			27
Antisense strand		23		

Use your knowledge of DNA structure to complete the table by filling in the missing boxes.

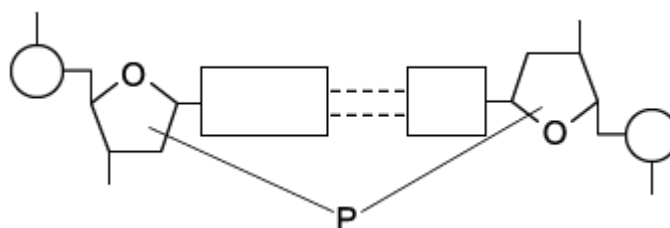
(2 marks)

- (c) Indicate with a tick or ticks (✓) in the table below the chemical group(s) that appear(s) at the two ends of a single strand of DNA.

	Deoxyribose sugar	Phosphate
3' (3-prime) end		
5' (5-prime) end		

(1 mark)

3 (a) The diagram below shows a base pair within a molecule of DNA.



Identify part **P** of this section of DNA

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(1 mark)

(b) Scientists sequenced the gene for a hormone, in order to understand more about why some individuals stop producing this hormone. The scientists determined that the gene consisted of 1 500 base pairs; 30% of the total bases were cytosine.

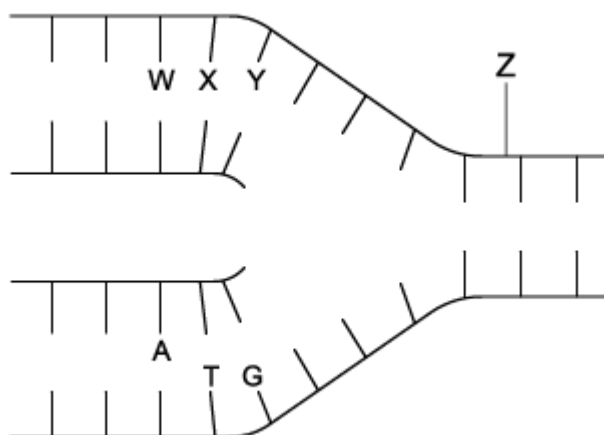
How many nucleotides of adenine and guanine were there in this sample of DNA?

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(2 marks)

(c) Describe the conventional numbering system for carbon atoms in a pentose sugar such as the ribose or deoxyribose sugars found in RNA and DNA. You may sketch a diagram to illustrate your answer.

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(3 marks)

- 4 (a) The diagram below shows the process of DNA replication. The horizontal lines represent the positions of bases.



Identify the parts of the DNA molecule represented by the labels **W**, **X**, **Y** and **Z**.

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(2 marks)

- (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	32.8	17.2	17.2	32.8
Caterpillar	33.1	16.9	16.9	33.1
Mouse		22.4		
Virus	24.7	24.1	18.5	32.7

Calculate the missing figures for mouse DNA and complete the table.

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(2 marks)

- (c) Humans and caterpillars have very similar percentages of each base in their DNA but are not the same class of organism.

Use your knowledge of DNA structure and function to explain how this is possible.

(3 marks)

- (d) The DNA of the virus is different from that of the human, caterpillar and mouse. Some viruses contain single-stranded DNA that is not base-paired to a complementary strand. Use data from the table in question 4b) to show evidence for this difference.

(2 marks)

- 5 Within the nucleus, DNA is replicated semi-conservatively in order to produce new cells.

State **two** features of DNA and explain how these features are important in the process of semi-conservative replication of a cell's DNA.

(2 marks)

Hard Questions

1 (a) The ends of a DNA strand are referred to as the 3' end and the 5' end.

Describe the aspects of DNA structure that give rise to this naming system.

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(3 marks)

(b) The structure of DNA has many characteristics that enable it to carry out its function.

(i) Identify **two** structural features that help DNA to carry out its function.

[2]

(ii) For each feature identified at part i), explain how it assists with DNA function.

[2]

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(4 marks)

2 (a) 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 μm .

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

Calculate the number of Kb in the DNA of the fruit fly. Give your answer to the nearest whole number.

(2 marks)

(b) The amount of DNA found in the nucleus of cells can vary amongst people, with each human chromosome containing between 5×10^4 and 26×10^4 Kb of DNA.

Suggest **one** reason why people might have different quantities of DNA to each other.

(1 mark)

(c) Other than for use in replication, explain **one** advantage of DNA molecules having two strands.

(1 mark)

3 (a) A section of DNA contains 1,200 base pairs.

- The number of guanine molecules on strand one was counted as 156.
- The number of cytosine molecules on strand one was counted as 209.
- The number of adenine molecules on strand two was counted as 264.

Complete the table below to include the total number of each base present in the section, and the % composition of each base.

	Number of molecules present	% composition
Adenine		
Cytosine		
Guanine		
Thymine		

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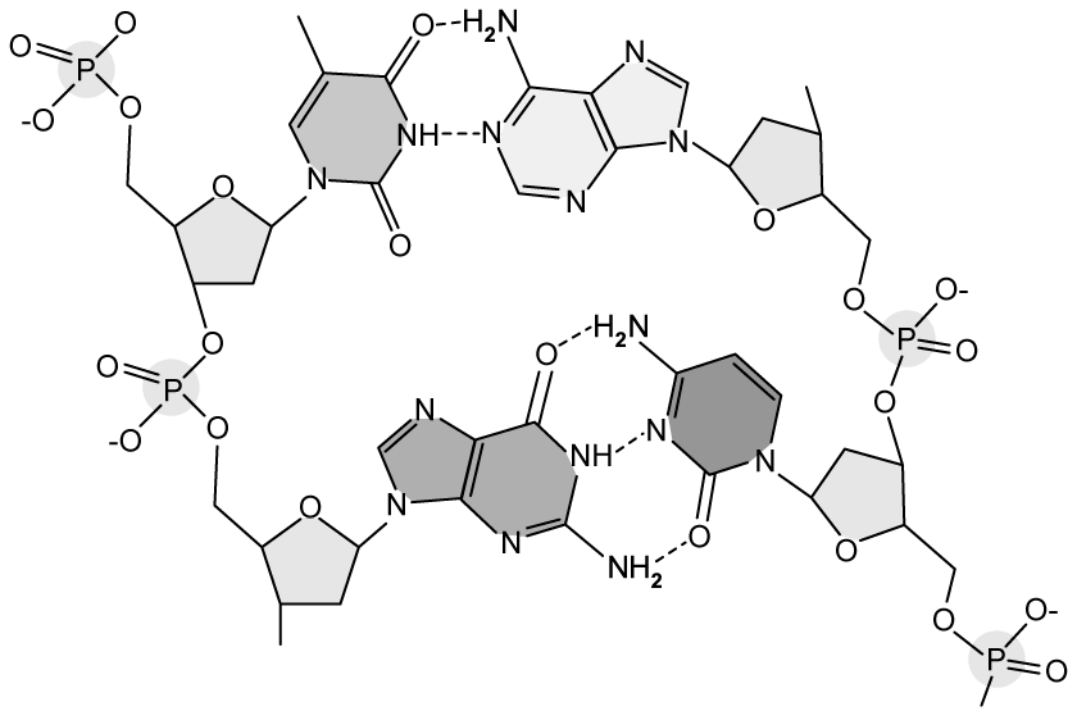
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(4 marks)

(b) The image below shows a section of the skeletal formula of a DNA molecule.

Number the carbon atoms of all the pentose sugars shown in the image using the standard numbering format.



(2 marks)

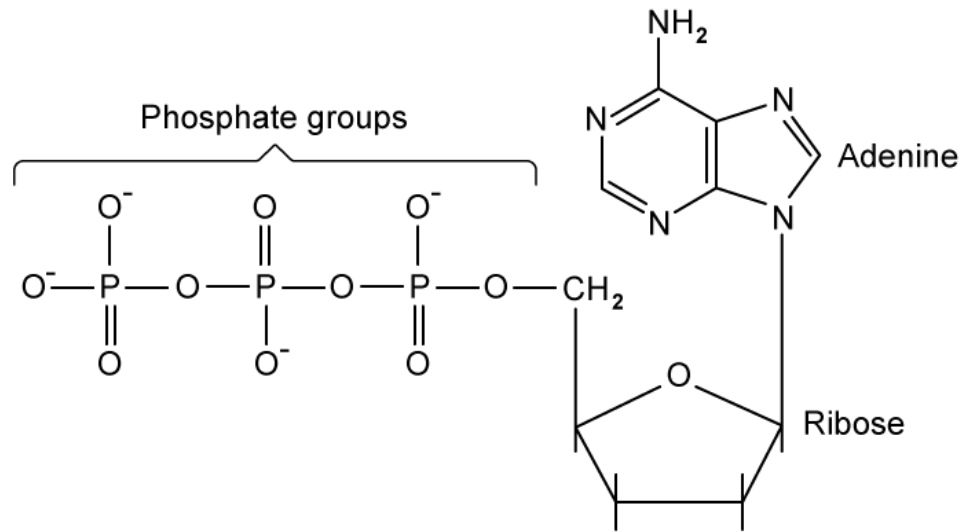
- (c) The DNA nucleotides are covalently bonded together in the sugar-phosphate backbone between the pentose sugar and the phosphate group, however, they are hydrogen bonded together between the bases.

Explain why both types of bonds are important for the functioning of DNA.

(2 marks)

- 4 (a) ATP is a source of energy used in cells and is produced from processes such as respiration.

The structure of ATP is shown in the diagram below.



Use the information in the diagram, as well as your own knowledge, to compare and contrast the structure of ATP with an adenine DNA nucleotide.

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(4 marks)

- (b) Explain how the structure of DNA allows replication.

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(4 marks)