

DNA

Mark Scheme



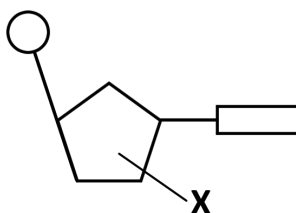
www.scienceexamssorted.co.uk

1. DNA is the molecule found in living cells that contains the unique genetic code for an organism. Circle the letter of the correct answer for each.

- a) A human cell contains a length of DNA that carries the code for making which substance?

D – is the only correct answer.	1 mark
	Total: 1 mark

- b) The figure below shows a DNA nucleotide. Which answer identifies structure X?



B – is the only correct answer.	1 mark
	Total: 1 mark

- c) The diagram shows a human sperm cell. Structure A on the diagram contains DNA. Identify structure A.

C – is the only correct answer.	1 mark
	Total: 1 mark

- d) What is defined as a length of DNA that codes for a protein?

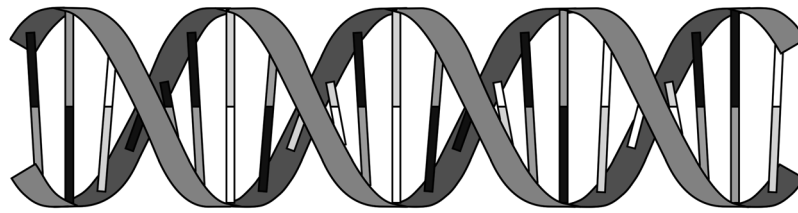
D – is the only correct answer.	1 mark
	Total: 1 mark

- e) The structure of a DNA molecule is best described as a:

B – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 5 marks)

2. The figure below shows a small section of DNA.



a) DNA passed from parent to offspring when an organism reproduces.

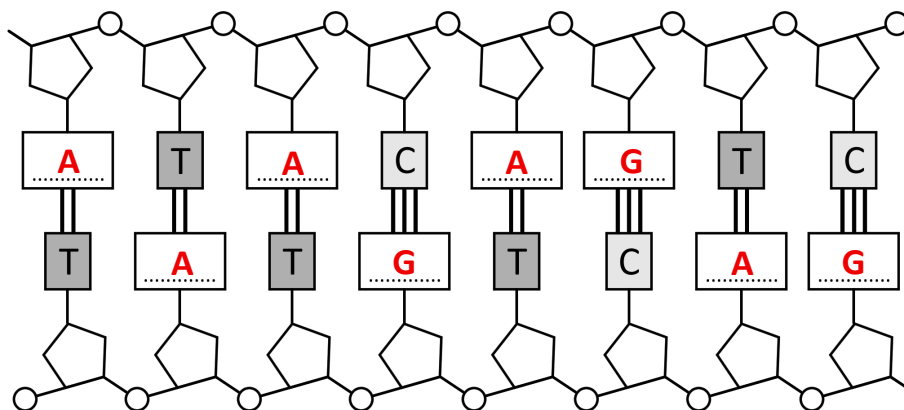
What is DNA short for?

Deoxyribonucleic	Do not accept incorrect spelling.	1 mark
acid		1 mark
		Total: 2 marks

b) The structure of DNA was determined in 1953 by which **two** scientists?

James <u>Watson</u>	1 mark
Francis <u>Crick</u>	1 mark
Total: 2 marks	

The figure below shows a short section of DNA showing some of the nitrogenous bases.



c) Complete the figure above for the missing nitrogenous bases.

Bases completed correctly from left to right.	2 marks
Award 2 marks for all 5 bases correct. Award 1 mark for 3 or 4 bases correct.	
Total: 2 marks	

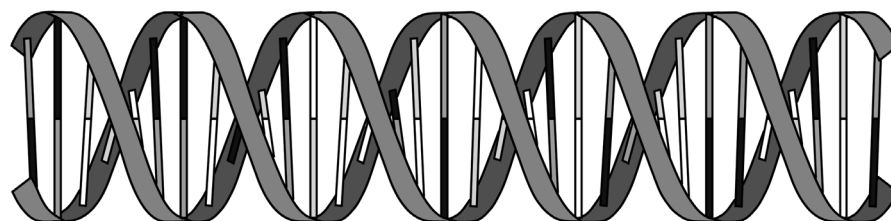
d) Calculate the mass of DNA the scientist should expect to obtain from a haploid human cell.

Give your answer in nanograms.

$0.0084 \div 2$	1 mark
0.0042 ng	1 mark
Award 2 marks for the correct answer without any working.	
Total: 2 marks	

(Total for Question 2 is 8 marks)

3. The figure below shows DNA.



a) Describe the structure of DNA, including the roles of the scientists involved in its discovery.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Simple statements are made about the structure of DNA (e.g., it is a double helix). At least one scientist is named.
Level 2	3 - 4	A good description of the DNA structure is given and the scientists are named with some description of their roles. The link between the evidence and the model may be less clear, or one aspect of the question
Level 3	5 - 6	A detailed and coherent description of the DNA structure is given, correctly linking this to the key contributions of the scientists involved. The roles of Franklin, Watson, and Crick are explained, showing a clear understanding of how evidence led to the final model. Appropriate scientific terminology is used throughout.

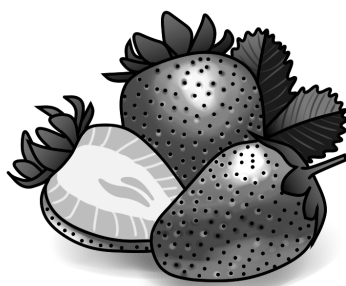
Indicative content:	
DNA Structure: • DNA is a polymer / made of repeating units. • The repeating units are called nucleotides. • It consists of two strands. • The strands are twisted to form a double helix. • Each strand has a sugar-phosphate backbone. • Reference to complementary base pairing. Roles of Scientists: • Watson and Crick discovered the double-helix structure / created the model. • Rosalind Franklin (and Maurice Wilkins) provided the evidence for the structure. • Franklin used X-ray diffraction / crystallography. • Her work showed that DNA was a helix of a constant diameter. • This evidence was used by Watson and Crick to build their model.	
	Total: 6 marks

b) Describe the structure of a DNA nucleotide and identify which bases pair together and the type of bond that forms between them.

A description to includes the following:	
A nucleotide consists of a(deoxyribose sugar, a phosphate (group) and a base.	1 mark
A (adenine) pairs with T (thymine).	1 mark
C (cytosine) pairs with G (guanine).	1 mark
(Weak) hydrogen bonds form between the bases.	1 mark
	Total: 4 marks

(Total for Question 3 is 10 marks)

4. DNA is found within the cell of an organism. The figure below shows some strawberries.



Describe the key practical steps a student would need to follow to extract a sample of DNA from the strawberry, starting with the whole fruit and ending with the visible DNA.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Simple, relevant statements about the procedure are made. The answer may be a list of disconnected points or describe only one or two stages of the process (e.g., mashing the fruit, adding alcohol).
Level 2	3 - 4	A method is described with the correct key stages, but the sequence may be unclear, or some detail is missing. Most of the key substances are named, but their role or timing might be incorrect.
Level 3	5 - 6	A detailed, logical, and coherent method is described which would allow the practical to be successfully followed. The key stages of breaking down cells, filtration, and precipitation are correctly sequenced. The key substances (detergent, salt, ethanol) are correctly named and used appropriately within the method.

Indicative content:	
Stage 1: Breaking down the cells • Mash / crush / blend the strawberries. • This breaks open the cell walls. • Mix the mashed strawberries with a solution containing detergent/washing-up liquid and salt. • The detergent breaks down the cell membranes and nuclear membranes (to release DNA). • The salt causes the DNA to clump together. • (Allow optional step of incubating in a water bath to speed up the process / denature enzymes). Stage 2: Separating the DNA. • Filter the mixture (e.g., through filter paper or gauze). • This is to separate the cell debris from the solution containing the DNA. Stage 3: Precipitating the DNA. • Collect the filtrate (the liquid that passes through the filter). • Gently pour ice-cold ethanol / alcohol down the side of the beaker onto the surface of the filtrate. • DNA is insoluble in cold ethanol and precipitates out of the solution. • The DNA will appear as a white, stringy substance at the interface between the two layers.	
	Total: 6 marks

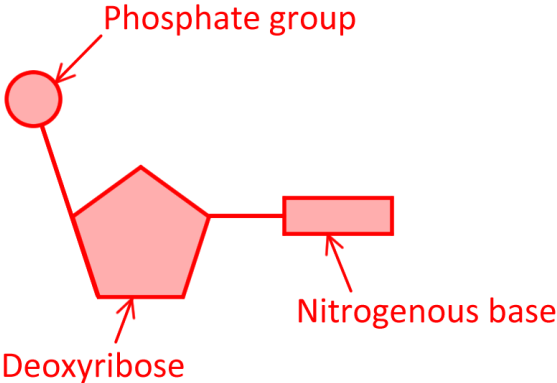
(Total for Question 4 is 6 marks)

5. In a prokaryotic cell, DNA is often found loose in the cytoplasm.

a) Why is the DNA of a prokaryotic cell not found in the nucleus?

Any two from:	
Prokaryotic cells / prokaryotes do not have a nucleus.	1 mark
They lack a nuclear membrane / envelope.	1 mark
So the genetic material / DNA is free in the cytoplasm.	1 mark
	Total: 2 marks

b) In the space below draw a **labelled** DNA nucleotide.

	
Diagram shows three components correctly joined (phosphate-sugar-base).	1 mark
Correctly labels two of: phosphate, (deoxyribose) sugar, base.	1 mark
Correctly labels the third component.	1 mark
	Total: 3 marks

The two strands of a DNA molecule are linked by complementary bases.

c) Describe how the complementary bases are linked in a DNA molecule.

A description to include:	
Adenine bonds to Thymine (A bonds to T) and Cytosine bonds to Guanine (C bonds to G).	1 mark
Joined by (weak) hydrogen bonds.	1 mark
	Total: 2 marks

d) The figure below shows a small section of a DNA molecule.

Write the sequence of bases that is complementary for the DNA molecule shown below.

A	A	C	T	A	A	C	G	C	A	T	T
T	T	G	A	T	T	G	C	G	T	A	A

Award 2 marks for the fully correct sequence. Award 1 mark if there is one error.	
	Total: 2 marks

(Total for Question 5 is 9 marks)

6. This question is about DNA and RNA.

a) What does RNA stand for?

Ribonucleic acid.	1 mark
	Total: 1 mark

b) Describe **two** similarities between the structure of a DNA molecule and the structure of an RNA molecule.

A description to include any two of the following:	
Both are polymers / made of repeating units called nucleotides.	1 mark
Both have a sugar-phosphate backbone.	1 mark
Both contain a phosphate group (in each nucleotide).	1 mark
Both contain a pentose sugar.	1 mark
Both contain the bases Adenine (A), Guanine (G) and Cytosine (C).	1 mark
	Total: 2 marks

c) Describe **two** differences between the structure of a DNA molecule and the structure of an RNA molecule.

A description to include any two of the following:	
DNA is double-stranded whereas RNA is single-stranded.	1 mark
DNA contains deoxyribose sugar whereas RNA contains ribose sugar.	1 mark
DNA has the base Thymine (T) whereas RNA has the base Uracil (U).	1 mark
	Total: 2 marks

d) Explain the main functional role of DNA in a cell and outline **two** different roles of RNA molecules in the process of protein synthesis.

An explanation to include the following:	
stores the genetic information / code for making proteins.	1 mark
And any two from:	
mRNA carries a copy of the gene	1 mark
Code from the nucleus to the ribosome.	1 mark
tRNA brings the correct / specific amino acids to the ribosome.	1 mark
	Total: 3 marks

(Total for Question 6 is 8 marks)