

7.1 DNA Structure & Replication

Question Paper

Course	DP IB Biology
Section	7. Nucleic Acids (HL Only)
Topic	7.1 DNA Structure & Replication
Difficulty	Hard

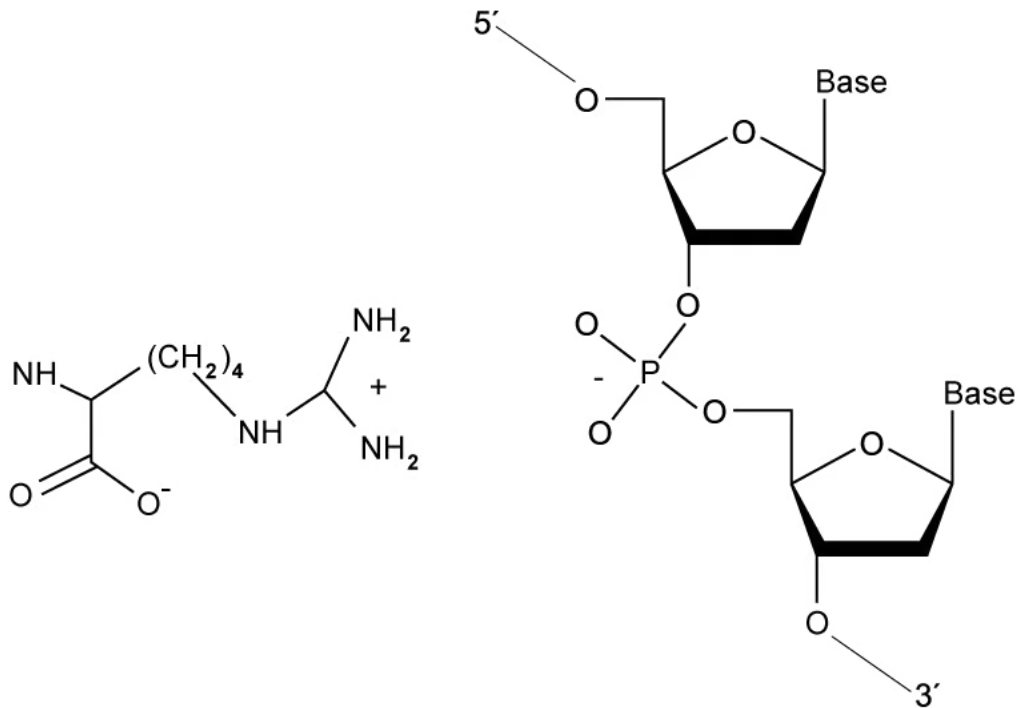
Time allowed: 50
Score: /39
Percentage: /100

Question 1a

a)

Arginine is an amino acid found in histone proteins and plays an important role in the interaction between histones and DNA within nucleosomes.

The diagram below shows the structure of arginine and a section of DNA within a nucleosome.



Suggest how arginine facilitates the interaction between histones and DNA, by using the information in the diagram.

[2 marks]

[2 marks]

Question 1b

b)

Explain the role of nucleosomes in chromosome structure.

[2 marks]

[2 marks]

Question 1c

c)

Packing ratio is determined by dividing the length of DNA packed into a structure by the length of the structure.

Chromosome 11 consists of about 1.35×10^8 base pairs and the distance between adjacent base pairs is 3.4 nm. The chromosome is about 5 μm in length during metaphase.

Calculate the packing ratio of chromosome 11. Show your working.

[2 marks]**[2 marks]**

Question 2a

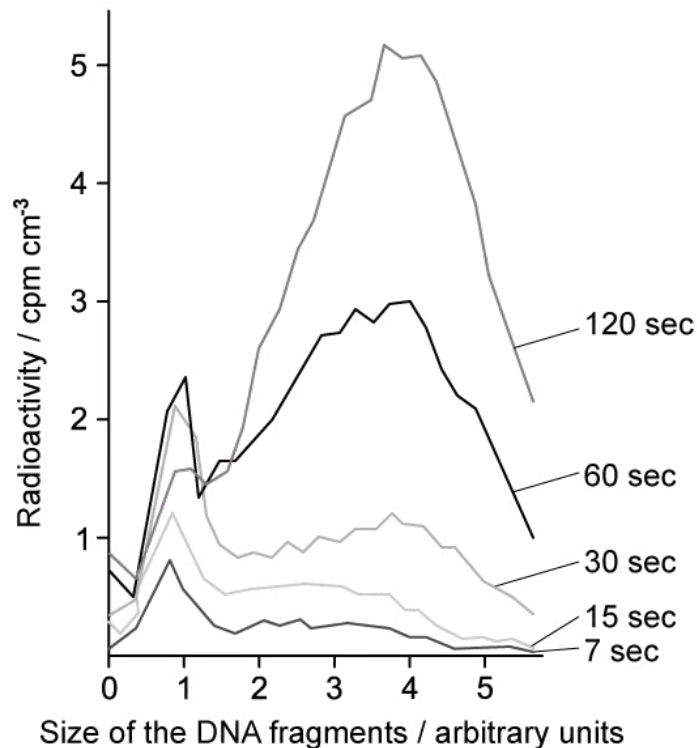
a)

A group of scientists studied the replication of DNA in *Escherichia coli* bacteria.

During their investigation, radioactive nucleotides were added to DNA that was actively replicating in a short pulse of about 5 seconds. This allowed the radioactive nucleotides to be incorporated into the new DNA strands.

This was followed by a "chase" period, during which an abundance of unlabelled nucleotides was added to the DNA for different amounts of time, between 7 and 120 seconds. After the isolation and centrifugation of the DNA molecules, the results were obtained.

The graph below shows the results of their investigation.



Contrast the results obtained at a "chase" period of 7 seconds with those obtained at 120 seconds.

[2 marks]

[2 marks]

Question 2b

b)

Explain the results obtained at a "chase" period of 60 seconds.

[2 marks]

[2 marks]

Question 2c

c)

Suggest a possible explanation for the low number of small fragments present at 120 seconds.

[1 mark]

[1 mark]

Question 2d

d)

Sketch a line on the graph of the predicted results that could be obtained at a "chase" period of 150 seconds.

[2 marks]

[2 marks]

Question 3a

a)
The following table shows the DNA base composition of different organisms. Note that for *E. coli*, the %C and %T has deliberately been left out.

Organism	%A	%C	%T	%G
Maize	26.7	23.3	27.0	23.0
Chicken	28.0	21.9	27.8	22.3
Octopus	33.0	17.2	32.1	17.7
Grasshopper	29.8	20.2	29.2	20.8
Sea urchin	32.6	16.9	33.1	17.4
Yeast	31.5	18.1	32.1	18.3
<i>E. coli</i>	24.7	-	-	X

State **two** deductions that can be made from the data.

[2 marks]

[2 marks]

Question 3b

b)
Calculate the possible value of **X** in the table in part a).

Show your working.

[2 marks]

[2 marks]

Question 3c

c)
The results from part a) are similar to those first obtained by Erwin Chargaff in the 1950s.

Suggest how Chargaff's research may have impacted the work of Crick and Watson.

[2 marks]

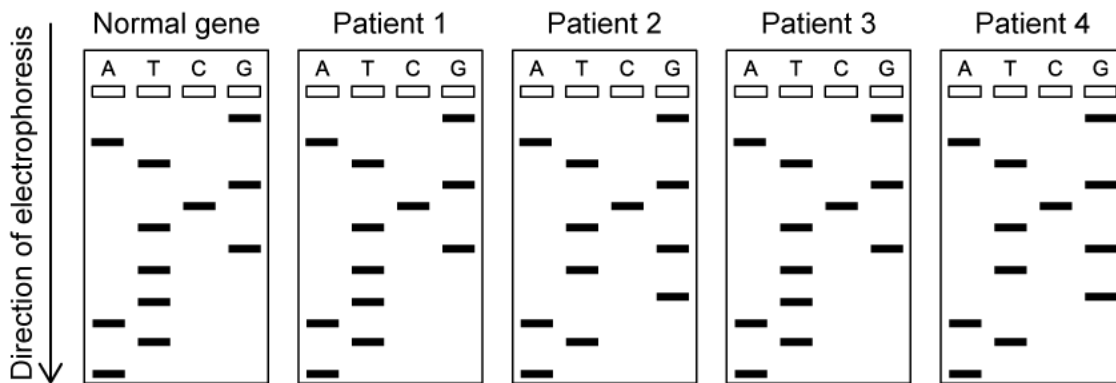
[2 marks]

Question 4a

a)

A mutation of the HTT gene may increase the risk of a person developing Huntington disease later in their lives. Blood samples from four different individuals were taken and the base sequences of a part of their HTT gene were sequenced using the chain termination method. These were compared to the normal base sequence of the HTT gene by reading from the smallest to the largest fragments.

The results from the gel electrophoresis are shown in the diagram below.



Identify the base sequence of the normal gene.

[1 mark]

[1 mark]

Question 4b

b)

Using the information in part a), deduce which patient(s) would have a higher risk of developing Huntington disease.

[1 mark]

[1 mark]

Question 4c

c)
During the chain termination method, modified nucleotides called dideoxynucleotides are used.

Contrast the structure and function of a dideoxynucleotide with a regular nucleotide.

[2 marks]

[2 marks]

Question 4d

d)
Suggest what would happen to DNA polymerase once a dideoxynucleotide is incorporated into the growing DNA strand.

[1 mark]

[1 mark]

Question 5a

One mark is available for clarity of communication throughout this question.

a)
Compare and contrast DNA profiling with the chain termination method of DNA sequencing.

[6 marks]

[6 marks]

Question 5b

b)

The structure of DNA was discovered due to the research and input from several different scientists.

Outline how the discovery of the structure of DNA led to the development of the theory of semi-conservative DNA replication.

[4 marks]**[4 marks]****Question 5c**

c)

Discuss the formation of Okazaki fragments during the process of replication on the lagging strand of a DNA molecule.

[5 marks]**[5 marks]**



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