

7.2 Transcription & Gene Expression

Question Paper

Course	DP IB Biology
Section	7. Nucleic Acids (HL Only)
Topic	7.2 Transcription & Gene Expression
Difficulty	Easy

Time allowed: 60
Score: /45
Percentage: /100

Question 1a

a)
Genes are not expressed equally in every cell of an organism. While essential genes needed for survival are continually expressed, other genes are regulated so that they are only expressed in specific cells, at specific times to produce specific amounts of protein.

Suggest why the regulation of gene expression is beneficial for an organism.

[1 mark]

[1 mark]

Question 1b

b)
Scientists have calculated that roughly 1.3% of a mouse genome is made up of coding sequences. Non-coding DNA sequences can produce functional RNA molecules called transfer RNA. Other non-coding sequences act as specific regions that interact with transcription factors to regulate gene expression.

i)
Define the term "coding sequence".

[1 mark]

ii)
Name the type of non-coding region that decreases or blocks transcription when a repressor protein binds.

[1 mark]

[2 marks]

Question 1c

c)
When a gene is expressed, transcription occurs.

List the **three** stages of transcription in chronological order.

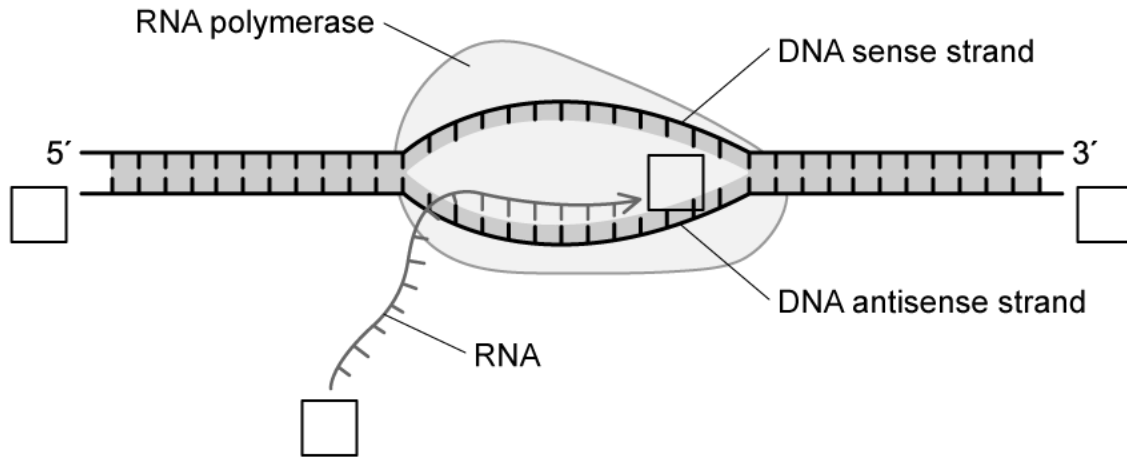
[1 mark]

[1 mark]

Question 1d

d)

The diagram below illustrates the action of RNA polymerase as it binds free RNA nucleotides to a growing RNA molecule.



Label the 5' and 3' ends of the DNA antisense strand and mRNA strand.

[2 marks]

[2 marks]

Question 2a

a)

Over 20,000 people died during the Dutch famine of 1944–1945. The "Dutch Hunger Winter" was unusual in that it started and ended very abruptly, allowing it to be analysed like an experiment to understand the effects of starvation and malnutrition on human health.

When investigating the short-term and long-term effects of the famine scientists found that pregnant women were particularly vulnerable. The children they gave birth to suffered from long-term health issues. As these children became adults they experienced significantly higher rates of obesity, diabetes and schizophrenia. Scientists also found that the Dutch Hunger Winter cohort had a 10% higher mortality rate after reaching 68 years old compared to those born before or after the famine. One study suggested that the conditions of the Dutch Hunger Winter silenced specific genes in unborn children and that they remained silenced through methylation.

i)

Define the term methylation.

[1 mark]

ii)

Explain how methylation suppresses the transcription of a gene.

[1 mark]

[2 marks]

Question 2b

b)

Methylation of DNA is an example of epigenetic modification which controls the expression of genes.

List **two** other types of epigenetic modification.

[2 marks]

[2 marks]

Question 2c

c)
Both epigenetics and mutations lead to changes in the expressed characteristics of genes.

State the main way in which epigenetics differs from mutations.

[1 mark]

[1 mark]

Question 2d

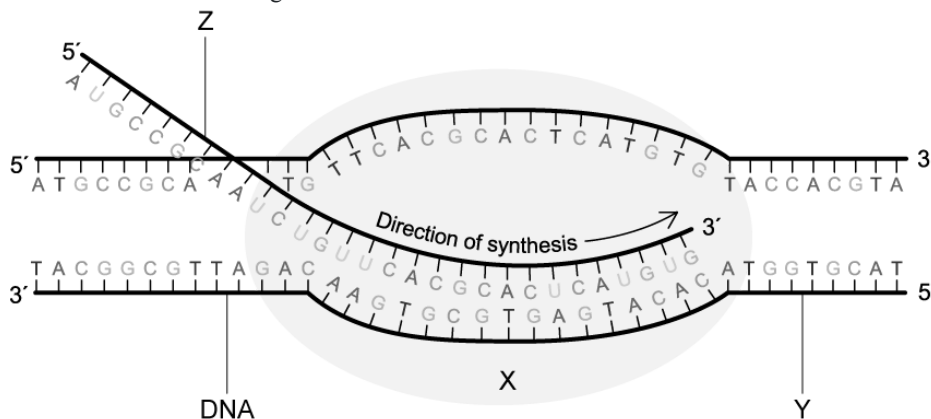
d)
Name another environmental factor aside from starvation, that can cause an organism's epigenome to change.

[1 mark]

[1 mark]

Question 3a

a)
The process of transcription is illustrated in the diagram below.



i)
Identify molecule X.

[1 mark]

ii)
Describe its role during transcription.

[2 marks]

[3 marks]

Question 3b

b)

From the image in part (a):

i)

Identify strand **Y**.

[1 mark]

ii)

State the significance of strand **Y** in the process of transcription.

[1 mark]

[2 marks]

Question 3c

c)

After the process of transcription is completed, molecule **Z** must undergo splicing before it can move to the cytoplasm.

Describe the changes that are made to molecule **Z** before it leaves the nucleus.

[2 marks]

[2 marks]

Question 3d

d)

The genetic code is universal across most forms of life.

Explain the importance of this statement.

[2 marks]

[2 marks]

Question 4a

a)

Gene expression can be regulated after an mRNA transcript has been produced through post-transcriptional modification. There are several advantages of post-transcriptional modification, one of them being that it helps prevent the degradation of mRNA.

i)

Explain why mRNA is an inherently unstable molecule.

[1 mark]

ii)

Suggest **two** other advantages of post-transcriptional modification in eukaryotic organisms.

[2 marks]

[3 marks]

Question 4b

b)

List **three** post-transcriptional events that must occur for pre-mRNA to become mature mRNA.

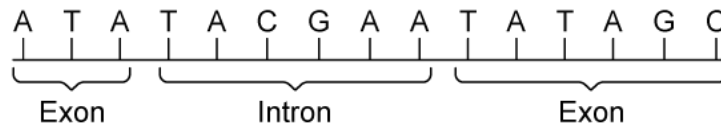
[3 marks]

[3 marks]

Question 4c

c)

The diagram below shows the base sequence on part of a DNA sense strand.



Deduce, with a reason, the sequence of bases on the mRNA transcribed from this strand.

[2 marks]

[2 marks]

Question 4d

d)

Explain why the proteome is bigger than the genome in eukaryotic organisms.

[1 mark]

[1 mark]

Question 5a

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

a)

Describe the structure and functions of nucleosomes.

[4 marks]

[4 marks]

Question 5b

b)

A transcription factor binds to the promoter region of a gene which allows RNA polymerase to bind and for transcription to occur.

Draw a simple diagram to illustrate this process.

[3 marks]

[3 marks]

Question 5c

c)

Outline how the lac operon functions to regulate gene expression in *Escherichia coli* when lactose is absent and when lactose is present.

[8 marks]

[8 marks]

