

2.6 Transcription & Translation

Question Paper

Course	DP IB Biology
Section	2. Molecular Biology
Topic	2.6 Transcription & Translation
Difficulty	Medium

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

Question 1a

- a) Myoglobin is a eukaryotic protein consisting of a single polypeptide chain of 153 amino acids.

Calculate the minimum number of DNA bases needed to code for Myoglobin.

[1 mark]

Question 1b

- b) Haemoglobin is another eukaryotic protein; it contains both α and β polypeptide chains. Some of the first seven amino acids of an α chain of haemoglobin, along with the corresponding bases in the sequence are shown below. An mRNA codon and amino acid table is also provided.

Amino acid sequence	Met	(i)	Leu	(ii)	(iii)	Ala	Asp
Base sequence in DNA antisense strand (3'→5')	TAC	CAC	GAC	AGA	GGA	CGG	CTG

		Second letter					
		U	C	A	G		
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G	Third letter
	C	CUU } Leu CUC } CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G	
	A	AUU } Ile AUC } AUA } ^a AUG Met/start	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G	
	G	GUU } Val GUC } GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G	

Use the information provided to identify the missing amino acids from the sequence of seven shown above.

[3 marks]

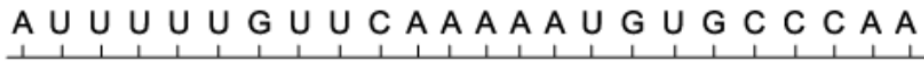
Question 1c

- c) A third eukaryotic protein, cytochrome c, is involved in the process of aerobic respiration. The diagram below shows part of the mRNA sequence and its corresponding amino acid sequence for cytochrome c in *Mus musculus* (house mouse) and *Loxodonta africana* (African elephant).

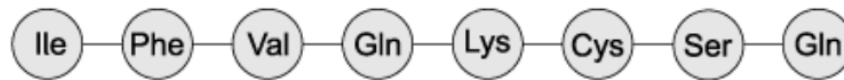
Amino acid sequence of mouse



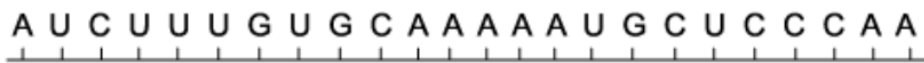
mRNA of mouse



Amino acid sequence of elephant



mRNA of elephant



Identify the tRNA anticodon that corresponds to the amino acid serine (Ser).

[1 mark]

Question 1d

- d) The triplet codes for the amino acid Ile in part (c) demonstrate a property of the genetic code known as degeneracy, or redundancy.

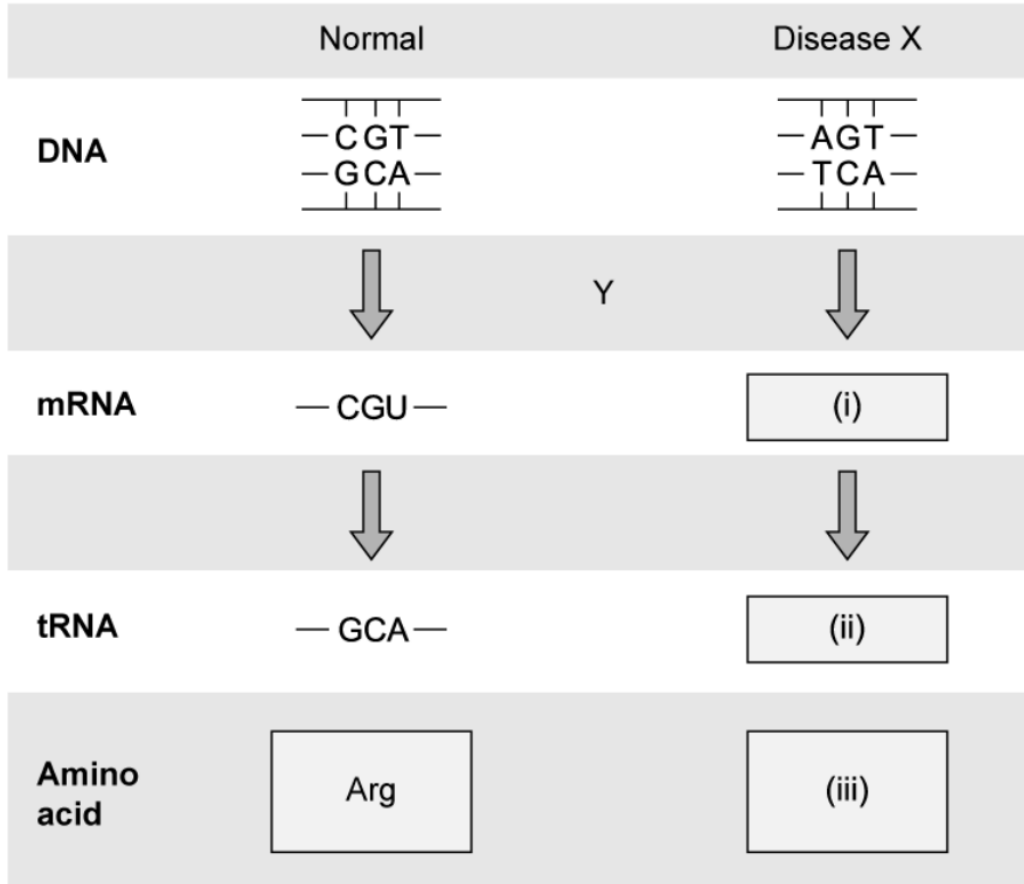
Use the information in part (c) to:

- i) Suggest what is meant when we say that the genetic code is degenerate/redundant.
- ii) Identify one **other** amino acid that demonstrates this property.

[2 marks]

Question 2a

- a) Disease X is a genetic condition. It is caused by various mutations, one of which is shown in the diagram below.



Identify the process marked Y in the diagram.

[1 mark]

Question 2b

b) The table below shows mRNA codons and their corresponding amino acids.

		Second letter				
		U	C	A	G	
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G
	C	CUU } Leu CUC } CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } Arg CGC } CGA } CGG }	U C A G
	A	AUU } Ile AUC } AUA } ^a AUG Met/start	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G
	G	GUU } Val GUC } GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } Gly GGC } GGA } GGG }	U C A G

Use the table above and your knowledge of protein synthesis to identify the contents of boxes (i)-(iii) in the diagram in part (a).

[3 marks]

Question 2c

c) Outline the role of transfer RNA in the process of protein synthesis.

[2 marks]

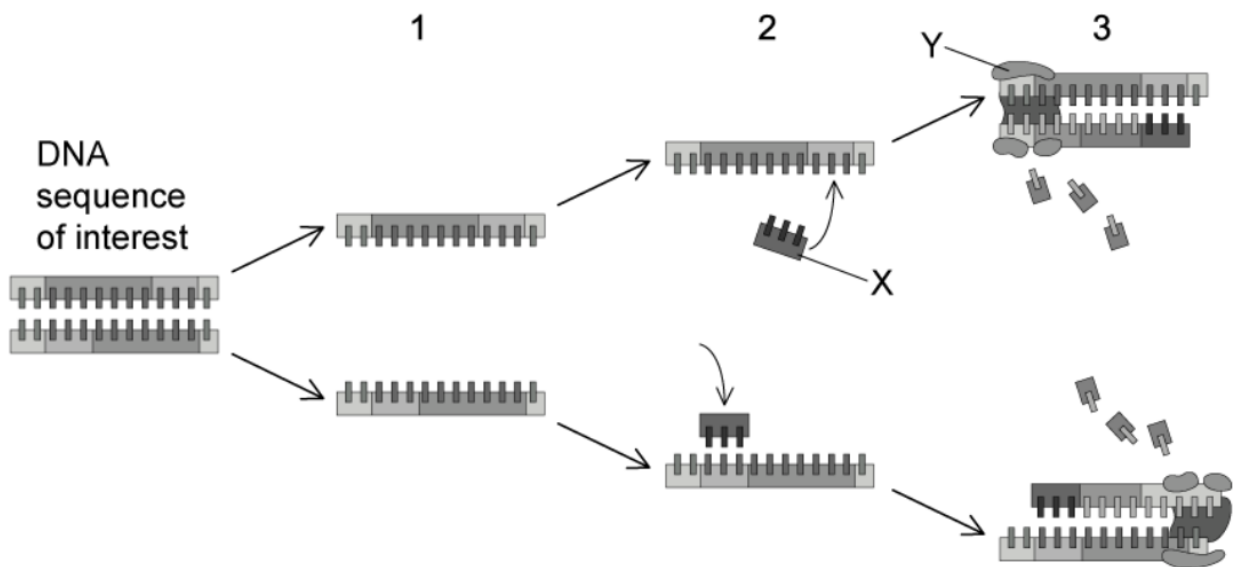
Question 2d

d) Explain why the protein produced as a result of the disease **X** mutation shown in part (a) does not function as it should.

[2 marks]

Question 3a

a) The diagram below shows one cycle of the polymerase chain reaction (PCR).



Outline the events that are taking place during stage 1 in the diagram.

[3 marks]

Question 3b

- b) Molecule **X** in the diagram shown in part (a) is a DNA primer.

State the role of a DNA primer in PCR.

[1 mark]

Question 3c

- c) Stage 3 in PCR involves an enzyme.

Explain how the enzyme is suitable for its role in PCR.

[2 marks]

Question 3d

- d) State **two** applications of PCR.

[2 marks]

Question 4a

- a) The table below shows the exposed bases of two tRNA molecules involved in the synthesis of a protein.

Bases of tRNA anticodon	UAU	GAC
Bases of corresponding DNA antisense strand	(i)	(ii)

Identify the base sequences found on the corresponding sections of the DNA antisense strands.

[2 marks]

Question 4b

- b) Outline how a gene codes for a polypeptide.

[3 marks]

Question 4c

- c) A polypeptide is formed when a series of amino acids join to form a chain.

Identify the following:

- i) The chemical reaction that joins two amino acids together in a polypeptide.
- ii) The type of bond that joins two amino acids together in a polypeptide.

[2 marks]

Question 5a

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

- a) Draw an annotated diagram to illustrate the structure of a DNA double helix.

[5 marks]

Question 5b

- b) Outline the advantages of producing insulin in bacteria.

[4 marks]

Question 5c

- c) Describe the process of transcription in eukaryotic cells.

[6 marks]