

SECONDARY SCHOOL IMPROVEMENT PROGRAMME (SSIP)



GRADE 12

SUBJECT: LIFE SCIENCES

LEARNER'S BOOKLET

&

Answer booklet

(Page 1 of 19)

SESSION 1

NUCLEIC ACIDS (Paper 2)

QUESTION 1: **15 Minutes** *(Taken from various sources)*

1.1 Various possible options are provided as answers to the following questions.

Choose the answer and write only the letter (A – D) next to the question number.

1.1.1 The structure of DNA was determined by using X-ray pictures produced by ...

- A Watson and Crick.
- B Franklin and Wilkins.
- C Watson and Franklin.
- D Crick and Franklin.

1.1.2 The DNA of different species only differs in the ...

- A components of the nucleotides.
- B sequence of the nucleotides.
- C type of bond between the nitrogenous bases.
- D type of sugar that it contains.

1.1.3 One strand of a DNA molecule has 60 adenine and 20 thymine molecules. How many adenine molecules are present in the double-stranded DNA molecule?

- A 60
- B 150
- C 80
- D 300

1.1.4 Which ONE of the following is CORRECT with regard to the structure of DNA and RNA?

- A RNA is double-stranded and DNA is single-stranded.
- B RNA contains uracil and DNA contains thymine.
- C RNA is a very long molecule while DNA is a short molecule.
- D RNA forms a double helix while DNA does not.

1.1.5 The shape of the DNA molecule was discovered by ...

- A Franklin, using evidence obtained from Watson and Crick.
- B Franklin, working independently of anyone else.
- C Watson and Crick, working independently of anyone else.
- D Watson and Crick, using some evidence obtained from Franklin.

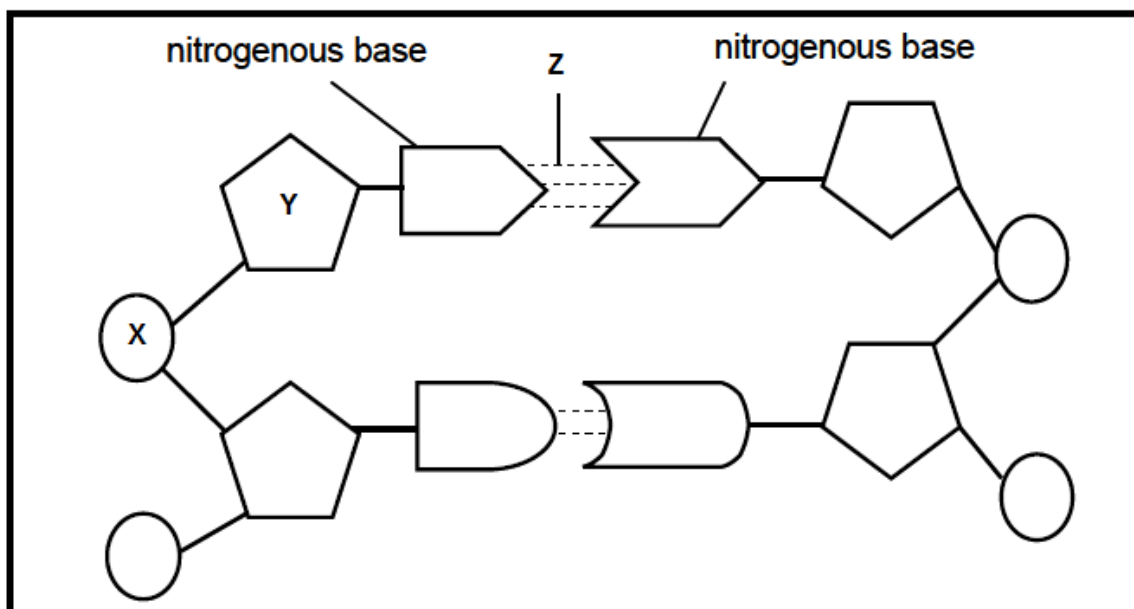
- 1.1.6. A person was seriously injured during a fight. Samples of blood were taken from the injured man (victim) and the crime scene. These samples were compared with blood samples collected from four people (**1** to **4**) suspected of injuring the man. The results are shown below.

VICTIM	CRIME SCENE SAMPLE	SUSPECTS			
		1	2	3	4
—	—	—		—	
	—		—	—	—
	—	—	—		
—	—			—	—
	—				—
	—		—		—
—	—	—		—	

Which one of the suspects were definitely on the crime scene?

- A 1
- B 2
- C 3
- D 4

- 1.1.7. The diagram below shows part of a DNA molecule.



The correct labels for parts **X**, **Y** and **Z** respectively are ...

- A deoxyribose sugar, phosphate and hydrogen bond.
- B phosphate, deoxyribose sugar and hydrogen bond.

- C ribose sugar, nitrogenous base and peptide bond.
 D phosphate, ribose sugar and hydrogen bond. (14)

1.2. Give the correct biological term for each of the following descriptions.
 Write only the term next to the question number (1.2.1 to 1.2.6) in the ANSWER BOOK.

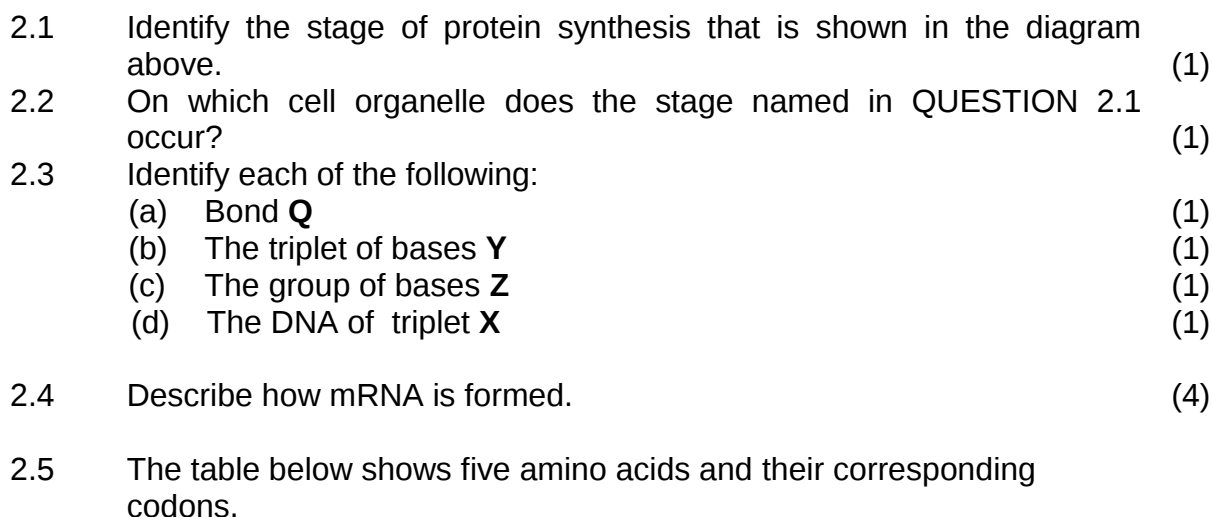
- 1.2.1. A bar code pattern formed from DNA
 1.2.2. The bonds formed between amino acids
 1.2.3. Openings in the nuclear membrane that allow mRNA to leave the nucleus
 1.2.4. Process by which mRNA is made in the nucleus
 1.2.5. Organelle on which proteins are made
 1.2.6. The monomers/building blocks of proteins (6)

1.3. Indicate whether each of the statements in COLUMN I applies to **A only**, **B only**, **both A and B** or **none** of the items in COLUMN II. Write **A only**, **B only**, **both A and B**, or **none** next to the question number (1.3.1 to 1.3.5) in the ANSWER BOOK.

1.3.1. The code for an amino acid on mRNA	A: codon B: anticodon
1.3.2. Discovered the structure of DNA	A: Watson B: Crick
1.3.3 The location of DNA in the cell	A: Nucleus B: Ribosome
1.3.4. Produced the first X-ray pictures	A: Watson B: Franklin
1.3.5. Discovered the shape of the DNA	A: Francis Crick B: James Watson

(10)
[30]

The diagram below shows a stage in protein synthesis.



AMINO ACID	CODON
Leucine	CUU
Glycine	GGA
Glutamic acid	CAA
Proline	CCU

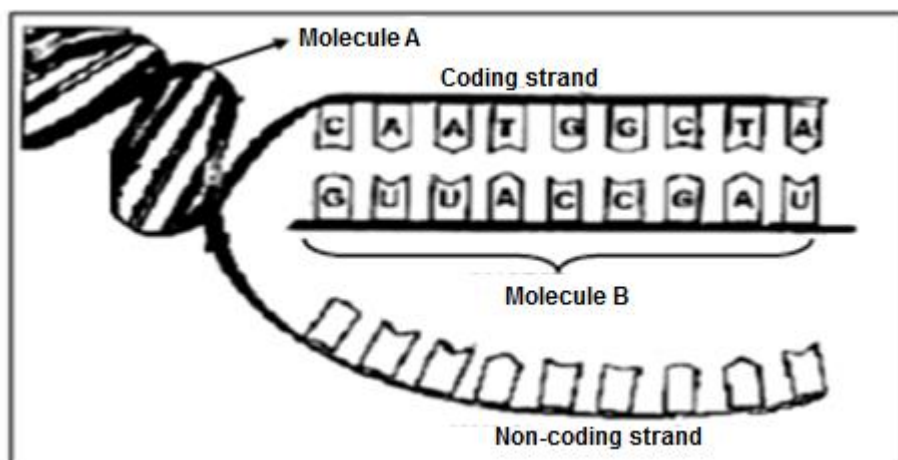
Use information from the table to:

- (a) Identify amino acids **1** and **4**. (2)
- (b) Write down the corresponding base triplets on the mRNA molecule for amino acid **5**. (1)

(1)
[13]

QUESTION 3: 18 Minutes (Taken from GDE June 2014)

3.1. The diagram below shows part of a process that occurs during protein synthesis. Study the diagram and answer the questions that follow.



- 3.1.1 Name the specific process shown in the diagram. (1)
3.1.2 Where, in the cell, does this process occur? (1)
3.1.3 Molecule A and molecule B are both nucleic acids. Tabulate TWO structural differences between these molecules. (5)
3.1.4 Describe the role of molecule B in protein synthesis (3)
3.1.5 Use the following table to give the sequence of the three amino acids that would be coded for by the section of DNA shown in the diagram above. (3)

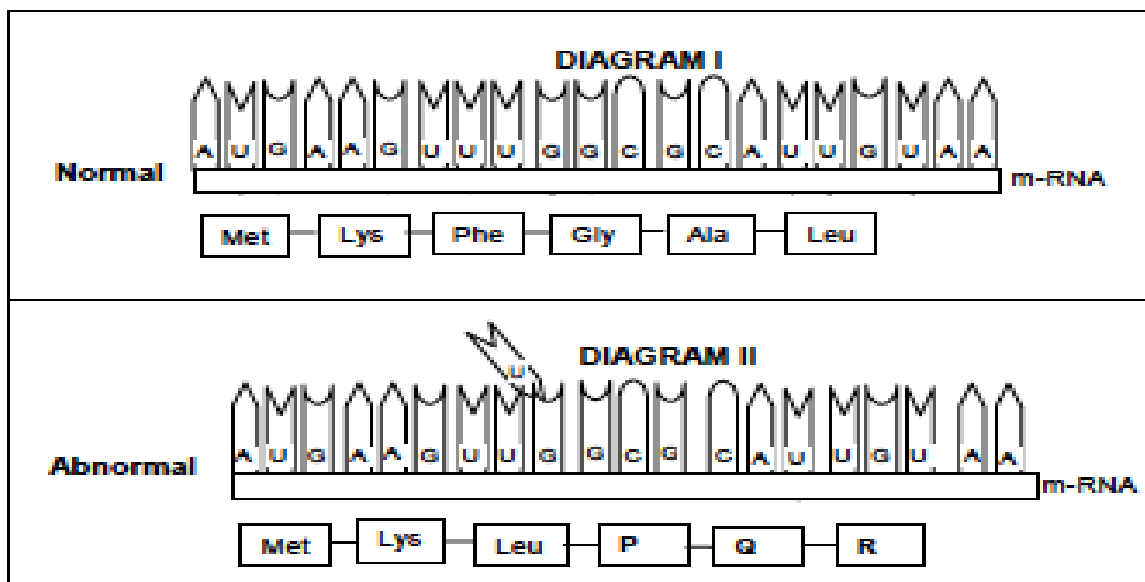
Anticodon	Amino acid
ACC	Threonine
CUA	Leucine
CAA	Glutamine
GUA	Valine
CAU	Histidine
UGG	Tryptophan
UUC	Lysine
GGC	Proline

- 3.1.6 Give the name of:
a) the molecule that carries the amino acids in the cytosol. (1)
b) the bond that forms between two amino acid molecules. (1)
3.1.7 Is the molecule produced by these three amino acids considered to be a protein? Explain. (3)
[18]

QUESTION 4: 12 Minutes (Taken from NW Sept 2015, Paper 2)

4.1. The normal coding for a protein is shown in **Diagram I**. In **Diagram II**, a uracil base was accidentally deleted during protein synthesis as a result of a mutation.

Study the diagrams carefully and answer the questions that follow.



- 4.1.1. Give the base sequence in the DNA for the first codon, **AUG**. (1)
- 4.1.2 Give the anticodon for the second base sequence, **AAG**. (1)

Study the table below:

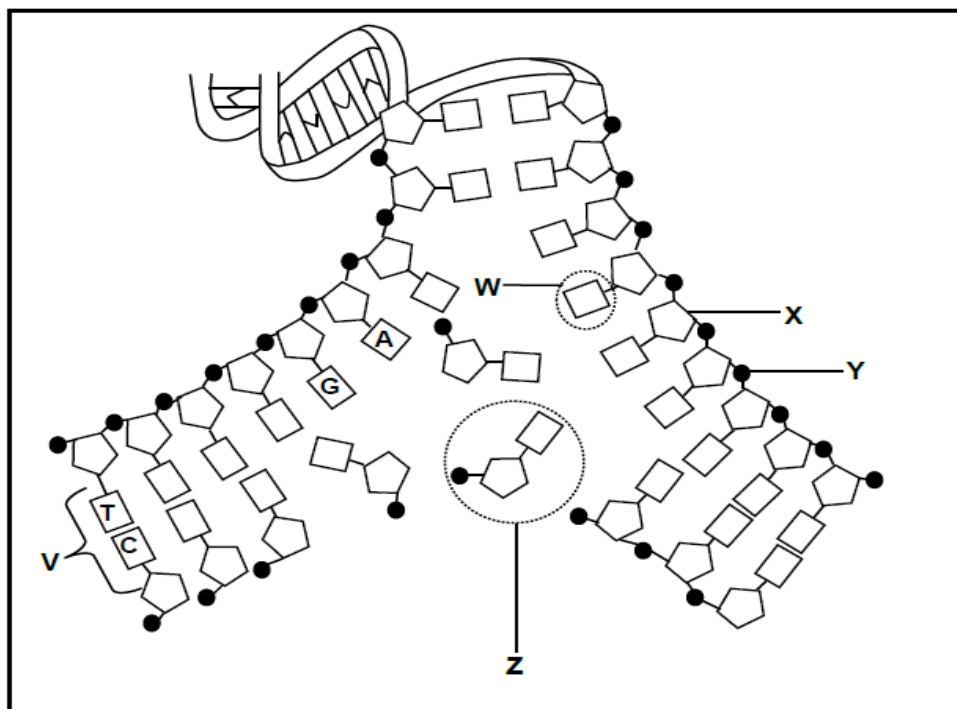
Amino acid	RNA base triplet	Amino acid	RNA base triplet
Leu (leucine)	UUG	Phe (phenylalanine)	AAA
His (histidine)	CAU	Gly (glycine)	CCT
Lys (lysine)	AAG/TTT	Met (methionine)	AUG
Pro (proline)	GGG	Ser (serine)	UGU
Ala (alanine)	CGA/GCG		

- 4.1.3 Use the table to identify the name of the new amino acid marked **Q** in the diagram after the mutation has taken place. (1)
- 4.1.4 Which stage of protein synthesis is depicted in the diagrams above? (1)
- 4.1.5 Describe the consequence of this mutation. (3)
- 4.1.6 Which type of bond is found between two amino acids? (1)
- 4.1.7 Describe the role of DNA during transcription. (4)

[12]

QUESTION 5: 6 minutes (Taken from DBE Mar 2015 P2)

5.1. The diagram below represents DNA replication.



- 5.1.1. Identify: (1)
 (a) X (1)
 (b) Z (1)
 5.1.2 Give TWO reasons why DNA replication is important in cells. (2)
 5.1.3 During what phase of the cell cycle does DNA replication take place? (1)
 5.1.4 Identify the nitrogenous base, labelled **W**, in the diagram. (1)
[6]

QUESTION 6: 20 Minutes

(Taken from DBE Nov 2015, Paper 2)

6.1. Describe the process of protein synthesis and the way in which this process would be affected by a gene mutation.

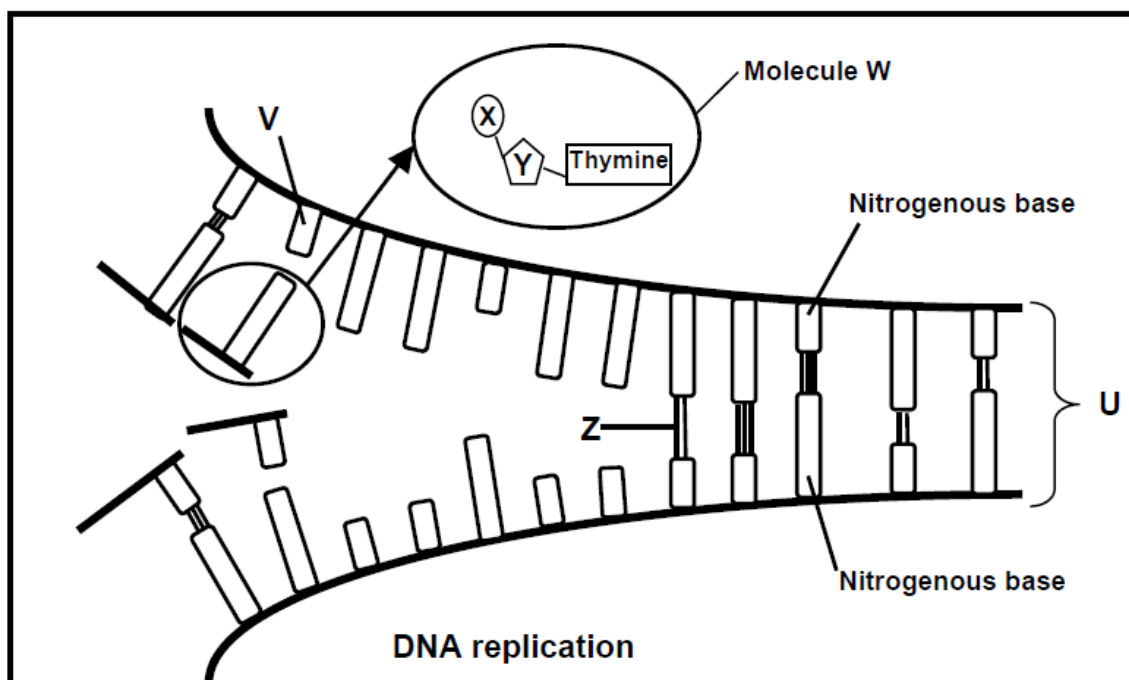
Content: (17)
 Synthesis: (3)

[20]

NOTE: NO marks will be awarded for answers in the form of tables, flow charts

QUESTION 7: **8 minutes** (Taken from DBE Nov 2015 P2)

7.1. The diagram below represents DNA replication.



7.1.1. Identify the following:

- (a) Molecules **W** and **U** (2)
- (b) Parts of molecule **W** labelled **X** and **Y** (2)
- (c) Bond **Z** (1)
- (d) Nitrogenous base **V** (1)

7.1.2. Where in the cell does this process take place? (1)

7.1.3. Name the phase of the cell cycle where replication takes place. (1)

[8]

QUESTION 8: **11 minutes** (Taken from DBE March 2015 P2)

- 8.1 The table below shows a partial DNA sequence from a human, as well as a codon table that can be used to determine which amino acids are required to make a protein.

Base triplet number	1	2	3	4	5	6	7
Human DNA sequence	ATG	TGT	CCA	TTA	ACG	TGC	ACA

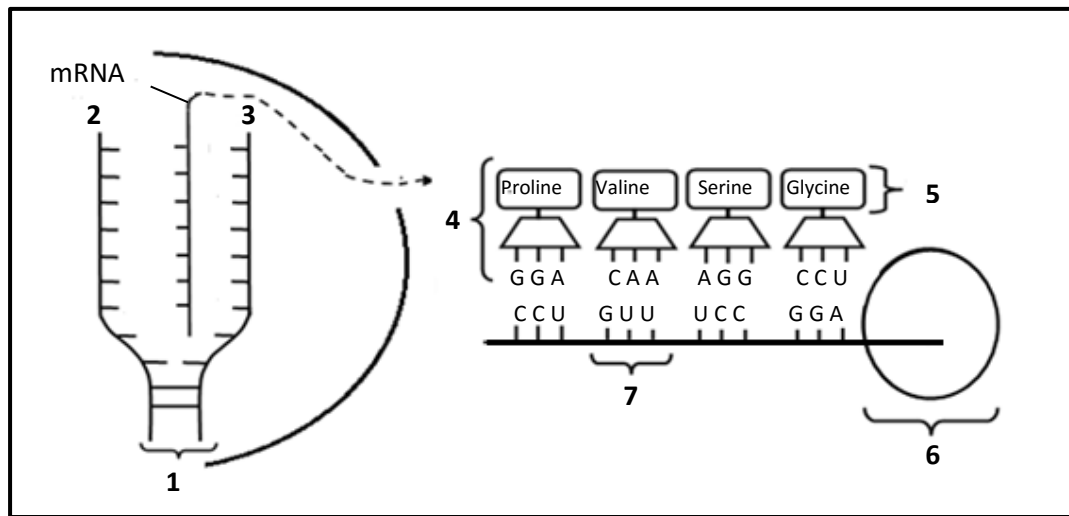
CODON TABLE	
Valine	GUU, GUG, GUA
Cysteine	UGU, UGC
Proline	CCA, CCU
Leucine	UUG, CUC, CUG, UUA
Threonine	ACG, ACA
Tyrosine	UAC, UAU

- 8.1.1. State ONE way in which the DNA molecule is biologically important. (1)
- 8.1.2. Name the codon that is formed from base triplet number **2** on the DNA sequence. (1)
- 8.1.3. Write down the names of the amino acids coded for by base triplets **6** and **7**. (2)
- 8.1.4. If a mutation changes base triplet **1** from ATG to ATA, why will this not change the protein formed? (2)
- 8.1.5. Describe the process of translation in protein synthesis. (5)

[11]

QUESTION 9: 5 minutes (Taken from DBE June 2105 P2)

9.1. The diagram below represents two stages of protein synthesis.



9.1.1 Provide labels for:

(a) Molecule **1** (1)

(b) Organelle **6** (1)

9.1.2 Give only the NUMBER of the part which represents a:

(a) DNA template strand (1)

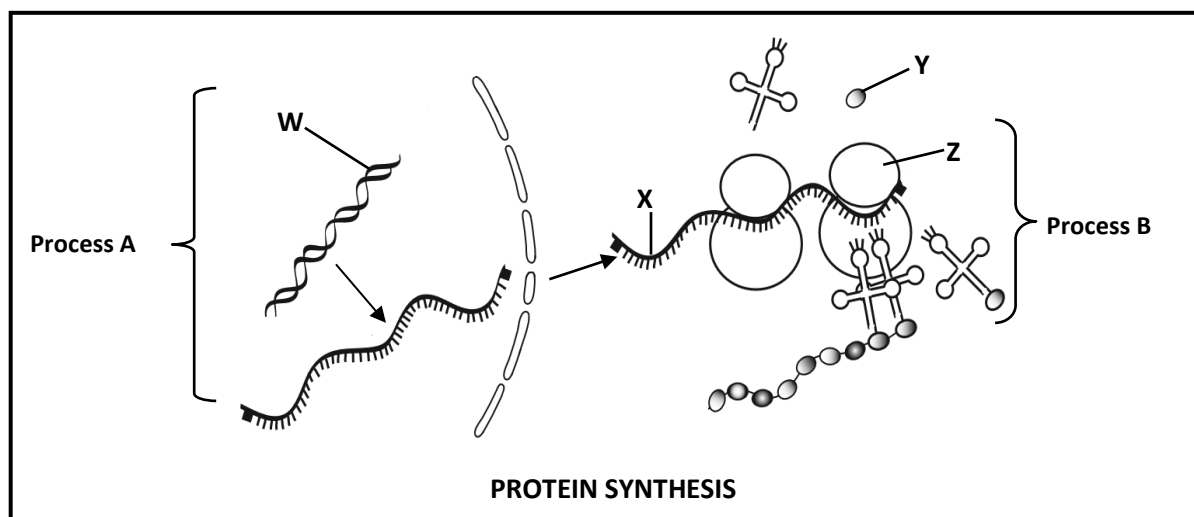
(b) Monomer of proteins (1)

(c) Codon (1)

[5]

QUESTION 10: **11 minutes** (Taken from DBE June 2015 P2)

10.1. The diagram below shows the process of protein synthesis



10.1.1 Identify the following molecules:

(a) **W** (1)

(b) **Y** (1)

10.1.2 The following sequence represents a part of the nitrogenous base sequence on molecule **X**.

AGA	AUG	GGA
triplet 1	triplet 2	triplet 3

(a) Write down the base sequence of the anticodon of triplet **1** shown above. (1)

The table below shows the amino acids that correspond with different DNA codes.

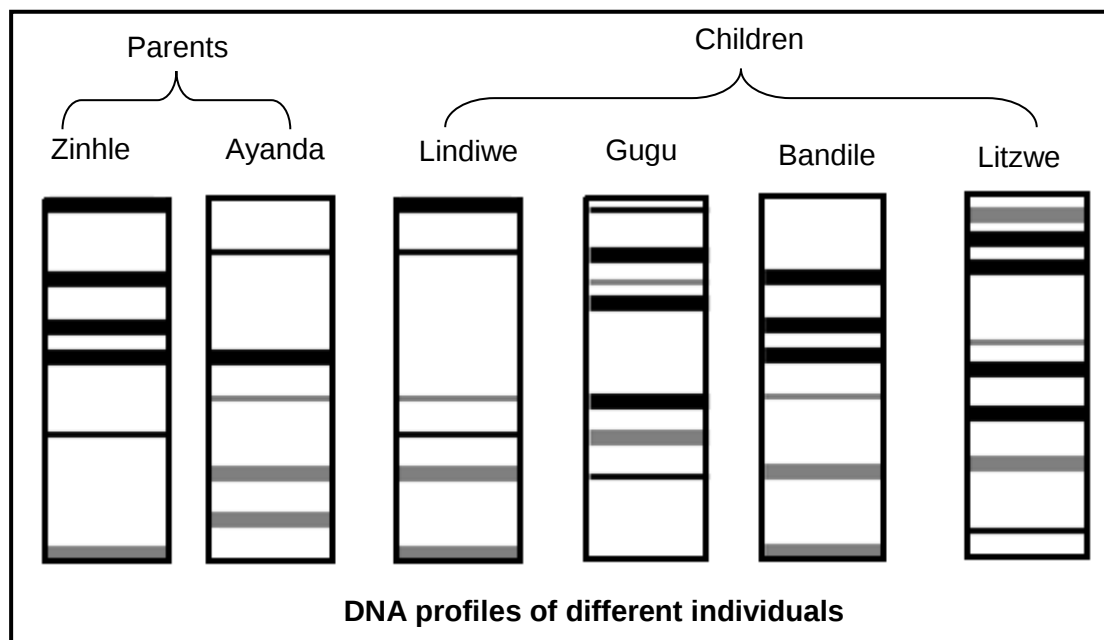
AMINO ACID	DNA CODE
Arginine	TCT
Glycine	CCT
Methionine	TAC

(b) Write down the correct sequence of amino acids for triplets **1** to **3**. (3)
[11]

QUESTION 11: 6 minutes

The diagram below shows the DNA profiles of six members of a family. The greater the similarity in the position of the bands in the DNA profiles of different individuals, the more closely they are related.

The parents, Zinhle and Ayanda, have four children. Two of the children are their biological offspring while the other two children are adopted.



- 11.1 Which TWO children are the biological offspring of Zinhle and Ayanda? (2)
- 11.2 Give an explanation for your answer to QUESTION 11.1 using evidence from the DNA profiles. (2)
- 11.3 Apart from paternity testing, state TWO ways in which DNA profiling is of use to humans. (2)
- [6]**

SOLUTIONS TO TYPICAL EXAM QUESTIONS – NUCLEIC ACIDS

QUESTION 1:

- 1.1.1 B ✓✓
- 1.1.2 B ✓✓
- 1.1.3 C ✓✓
- 1.1.4 B ✓✓
- 1.1.5 D ✓✓
- 1.1.6. B ✓✓
- 1.1.7. B ✓✓ (14)

- 1.2.
- 1.2.1. DNA Profiling ✓
- 1.2.2. Peptide bonds ✓
- 1.2.3. Nuclear pores ✓
- 1.2.4. Transcription ✓
- 1.2.5. Ribosome ✓
- 1.2.6. Amino acids ✓ (6)

- 1.3
 - 1.3.1. A only ✓✓
 - 1.3.2. Both A&B ✓✓
 - 1.3.3. A only ✓✓
 - 1.3.4. B only ✓✓
 - 1.3.5. Both A&B ✓✓ (10)
- [30]**

QUESTION 2:

- 2.1 Translation ✓ (1)
- 2.2 Ribosome ✓ (1)
- 2.3
 - (a) Peptide ✓ bond (1)
 - (b) Anticodon ✓ (1)
 - (c) Codon ✓ (1)
 - (d) GGA ✓ (1)
- 2.4
 - Transcription ✓
 - DNA unwinds ✓
 - and unzip ✓
 - One DNA strand acts as a template ✓ for forming mRNA.
 - Free nucleotides according to the DNA template ✓
 - U with A and G and C any 4 (4)
- 2.5
 - (a) 1 = Proline ✓
 - 4 = Glycine ✓ (2)

QUESTION 3

3.1.1 Transcription ✓ (1)

3.1.2 The Nucleus✓ (1)

3.1.3

DNA	RNA
- A double stranded molecule ✓	- A single-stranded molecule ✓
- The sugar is Deoxyribose✓	- The sugar is Ribose ✓
- Base pairing occurs✓	- No base pairing occurs✓
- Thymine is the complementary base to Adenine ✓	- Uracil is the complementary base to Adenine ✓

Any (2x2) + Correct column headings (DNA and RNA) ✓

(5)

Mark first two only

3.1.4 mRNA✓ forms a copy of the DNA molecule ✓ and then leaves the nucleus ✓ and goes to the ribosome✓ where it will determine the sequence of tRNA✓ molecules Any 3 (3)

3.1.5 Glutamine✓
Tryptophan✓
Leucine✓ (In this sequence only) Mark first three only (3)

3.1.6 a) tRNA✓
b) Peptide✓ (2)

3.1.7 No✓ A protein is made up of 50✓ or more amino acids. This molecule only has 3 amino acids✓ and is considered a tripeptide✓/polypeptide Any 3 (3)
[18]

QUESTION 4:

- 4.1.1. TAC ✓ (1)
- 4.1.2 UUC ✓ (1)
- 4.1.3 Histidine ✓ (1)
- 4.1.4 Translation ✓ (1)
- 4.1.5 - It changes the codon on the m-RNA✓,
- complementary to a different t-RNA molecule✓.
- Different amino acid sequence✓will follow
- and a different type of protein will be formed. ✓
- Which may lead to an abnormality/dysfunction ✓ Any (3)
- 4.1.6 Peptide ✓ bond (1)
- 4.1.7 - A portion of the DNA unwinds and unzips✓/ (H bonds break)
- DNA acts as a template✓
- DNA contains the code for the formation of specific proteins✓
- Forms the mRNA that copies the DNA code ✓ (4)

[12]

QUESTION 5

- 5.1.1 (a) Deoxyribose sugar ✓ (1)
- (b) Nucleotide ✓ (1)
- 5.1.2 • To ensure that each daughter cell has the correct amount of DNA✓
• Identical chromosomes✓/same genetic material to the parent cell (2)
- 5.1.3 Interphase ✓ (1)
- 5.1.4 T✓/thymine (1)

[6]

QUESTION 6:

PROTEIN SYNTHESIS

Transcription ✓

- Double stranded DNA unwinds ✓
- and unzips when ✓
- the hydrogen bonds break ✓
- and this is controlled by enzymes ✓
- One strand is used as a template ✓
- to form mRNA ✓
- using free RNA nucleotides from the nucleoplasm ✓
- The mRNA is complementary to the DNA ✓
- mRNA now has the coded message for protein synthesis ✓

Translation ✓

- mRNA moves from the nucleus ✓/to the ribosome
- Each tRNA carries an amino acid ✓
- tRNA carries the amino acid to the ribosome ✓
- When the anticodon on the tRNA ✓
- matches the codon on the mRNA ✓
- Amino acids become attached ✓in the sequence determined by the mRNA
- by peptide bonds ✓
- to form the required protein ✓

Max 13

EFFECTS OF A MUTATION

- A gene mutation affects arrangement/type of the nitrogen bases✓/nucleotides
- This changes the code on the DNA ✓
- which changes the code on the RNA ✓
- A different amino acid ✓may be coded for
- which causes a change in the amino acid sequence ✓in the protein
- leading to the formation of a different/alternate/no protein ✓

Max 4

ASSESSING THE PRESENTATION OF THE ESSAY

Criterion	Relevance (R)	Logical sequence (L)	Comprehensive (C)
Generally	All information provided is relevant to the question	Ideas are arranged in a logical/cause-effect sequence	All aspects required by the essay have been sufficiently addressed
In this essay in Q4	Only information relevant to the description of protein synthesis and the effects of mutation on the process is given	The description of protein synthesis and the effects of mutation on the process given are logical and sequential	At least 5 correct points in the description of transcription and 5 correct points in the description of translation and 2 correct points on the effects of mutation
Mark	1	1	1

Content: 17
Synthesis: 3

[20]

QUESTION 7

7.1.

7.1.1.(a) W – Nucleotide✓

U – DNA✓

(2)

(b) X – Phosphate /phosphate ion✓

Y – Deoxyribose✓ sugar

(2)

(c) Z – Hydrogen✓ bond

(1)

(d) V – Adenine ✓

(1)

7.1.2 Nucleus ✓

(1)

7.1.3 Interphase ✓

(1)

[8]

QUESTION 8

8.1.

8.1.1- DNA carries hereditary information✓

- DNA contains coded information for protein synthesis ✓ (Mark first ONE only) (Any 1) (1)

8.1.2 ACA✓

(1)

8.1.3 Threonine✓; Cysteine✓ (must be in correct order)

(2)

8.1.4 - Both ATG and ATA✓

- Code for the same amino acid/tyrosine ✓

(2)

8.1.5 - The anticodon on the tRNA matches the codon on the mRNA✓

- tRNA brings the required amino acid✓

- to the ribosome✓

- amino-acids are joined by peptide bonds✓

- to form the required protein✓

(Any 5)

(5)

[11]

QUESTION 9

9.1.1. (a) DNA✓

(1)

(b) ribosome✓

(1)

9.1.2. (a) 2✓

(1)

(b) 5✓

(1)

(c) 7✓

(1)

[5]

QUESTION 10

- 10.1.1. (a) DNA✓ molecule (1)
(b) Amino acid✓ (1)
- 10.1.2. (a) UCU ✓ (1)
(b) Arginine✓;Methione✓; Glycine✓ (3)
(must be in correct order) [6]

QUESTION 11

- 11.1 Lindiwe✓ and Bandile✓ (2)
- 11.2 They have DNA bands which correspond✓
with the banding patterns from both parents✓/ Zinhle and Ayanda (2)
- 11.3
- To investigate crimes✓/ resolve disputes
 - To identify organisms from their remains✓
 - To identify family relationships other than paternity✓, e.g. siblings or cousins
 - To test for the presence of specific alleles✓/ genes that cause a genetic disorder
 - To establish matching tissues for organ transplants✓
- Any 2 (2)
[6]