DNA: THE CODE OF LIFE

Checklist

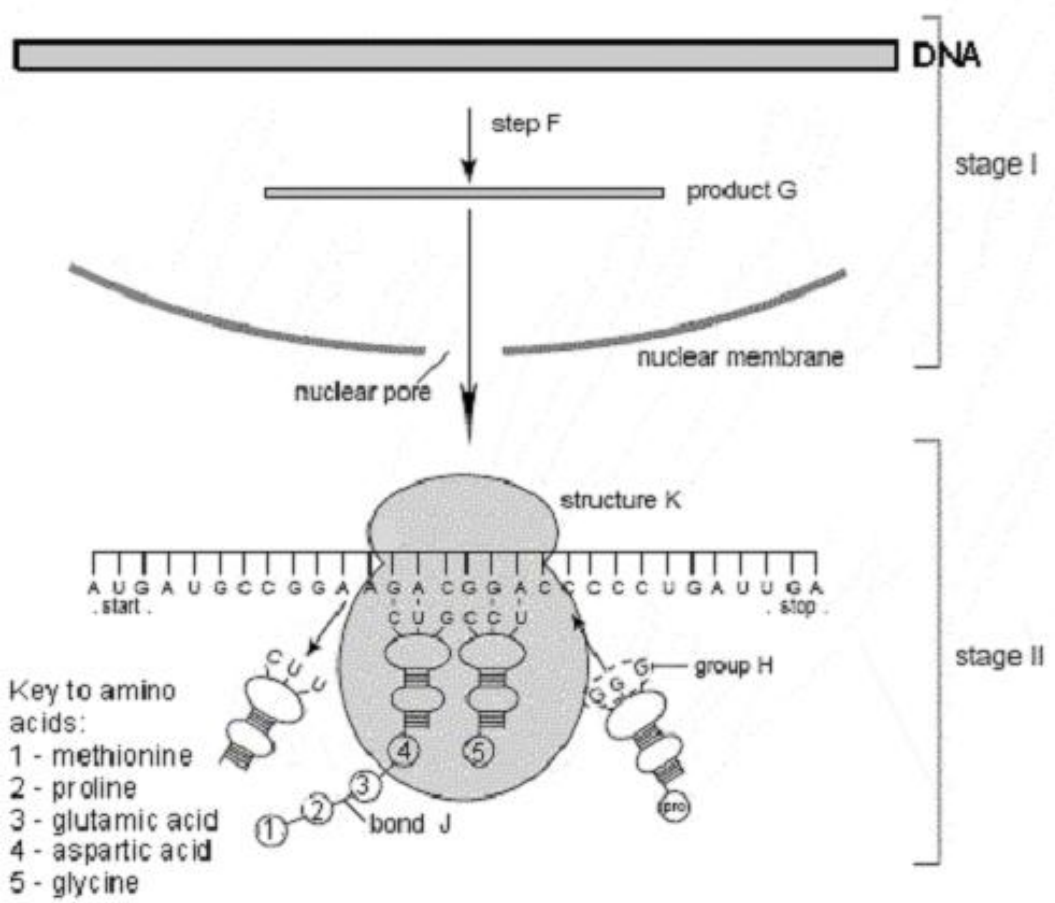
Make sure you …

- Revise the structure of the cell, especially the nucleus, ribosomes and cytoplasm
- Are able to name the two nucleic acids and state that are made of nucleotides
- Know that DNA is found in the DNA (nuclear DNA) and in mitochondria (mitochondrial DNA)
- Can describe the history of the discovery of the DNA molecule (Watson, Crick, Franklin and Wilkins)
- Know the structure of DNA – nitrogenous bases, sugar portion and phosphate portion
- You are able to describe DNA replication- when it takes place, where, how and what is the significance
- Are able to state what DNA fingerprinting is, its importance, and views for and against its use
- State the structure and location of mRNA and tRNA
- Can list the similarities between DNA and RNA and tabulate the differences between DNA and RNA
- Describe the process of Transcription and translation during protein synthesis

Exam Questions

Question 1

The following diagram outlines the production of proteins in a cell when DNA is activated.



1.1 At stage I the DNA molecule involved has, at codons 5, 6 and 7, the base sequence

A CTGCCTGGC

B CTGCCTCCC

C CTGCCTGGG

D CTGTTTGGG

1.2 In stage II

A structure K is made of tRNA

B the three bases of group H form an anticodon

C bond J represents a hydrogen bond

D the mRNA shown will code of a polypeptide containing 10 amino acids

1.3 The anticodon for glycine is

A GGA

B CCU

C CCT

D GGT

Question 2

The proportions of the four organic bases in a piece of DNA from a squirrel, a piece of DNA from a shark and in a piece of human mRNA are given below.

Type of nucleic acid	Proportion of organic bases(percentage)			
	A	G	C	T/U
Squirrel DNA	29	21	22	28
Shark DNA	28	22	21	30
Human mRNA	40	15	30	15

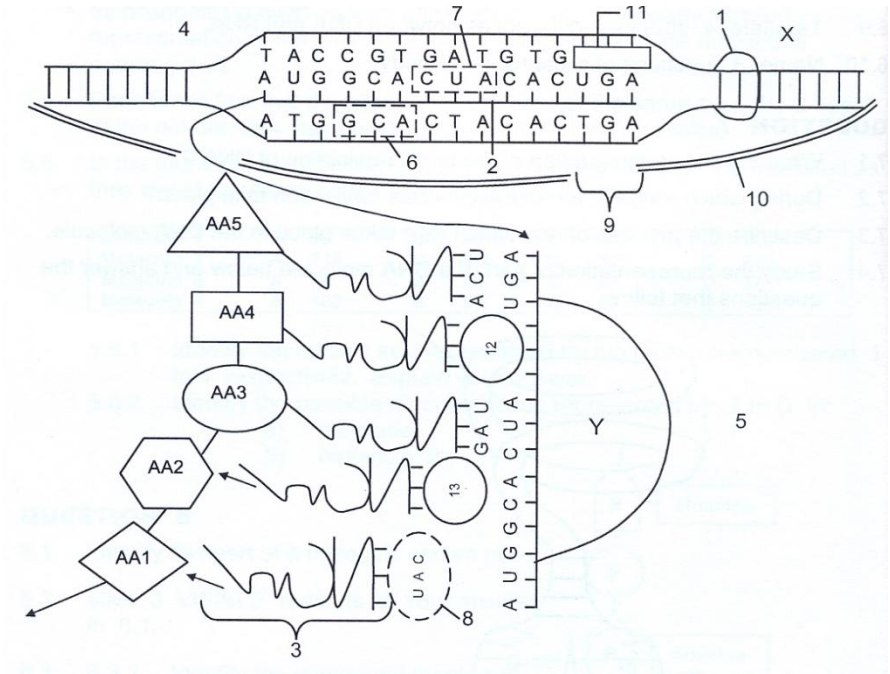
2.1 Explain why the proportion of A and G is approximately equal to the proportion of T and C in both pieces of DNA. (4)

2.2 Explain why a similar equality does not exist between the proportion of A and G and the proportion of U and C in the mRNA. (2)

2.3 Despite being very different organisms, the squirrel and the shark have similar proportions of the four different bases in their DNA. Explain how this is possible. (2)

Question 3

Study the diagrammatic representation of the role of DNA and RNA during the process of protein synthesis and answer the questions that follow



3.1 Identify the cell organelles represented by X and Y respectively. (2)

3.2 Identify the molecules numbered 1 to 3. (3)

3.3 Identify the groups of nucleotide bases as represented by 7 and 8 respectively. (2)

3.4 Give the name of the process during which the molecule number 2 is formed. (2)

3.5 Describe the process TRANSLATION. (5)

Make use of the table below to answer the question that follows:

Amino acid	Abbreviation	Codon on m-RNA
Serine	Ser	AGC
Glycine	Gly	CGA
Valine	Val	GUA
Cysteine	Cys	UGC
Tryptophan	Trp	UGA
Alanine	Ala	GCA
Leucine	Leu	CUA
Methionine	Met	AUG
Arginine	Arg	AGA
Histidine	His	CAC
Lycine	Lys	AAA

A fraction of an insulin molecule was extracted from cattle. The sequence of amino acids looks as follows:

His – Leu – Cys – Gly – Ser – His – Leu – Val

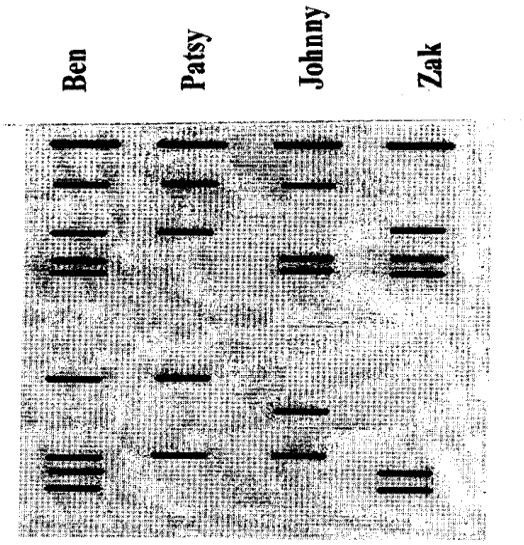
3.6 Write the sequence of the base triplets for the eight amino acids mentioned above as it would appear on the DNA template. (8)

Question 4

You are a forensic detective and specialize in child custody cases.

Patsy is a 32 year old single mother who is currently unemployed and living financially off her monthly child grant and a small savings account which she inherited from her mother. A year ago she fell pregnant again and now has given birth to a baby boy, Ben. Zak was Patsy's boyfriend at the time she fell pregnant, but left her after he suspected that she was seeing his best friend, Johnny. Her relationship with Johnny was intimate one night when she went to him for help after Zak came home drunk and hit her. She is determined to know who the father is as she cannot finance two children, and would appreciate some sort of financial support, which she is entitled to by law.

She proposes her case to you and you accept gladly because you know that both Zak and Johnny are extremely wealthy businessmen who could easily help support a child. You have DNA profiles/fingerprints done on all involved in your case. After gaining consent from all parties involved you send blood samples off to the National Forensics Laboratory in Pretoria for DNA profiling using certain genetic markers. Two weeks later the results return and are shown below.



4.1 Who is Ben's father? Justify your answer with evidence from the DNA fingerprint. (3)

4.2 Give one advantage and one disadvantage of DNA profiling in paternity testing. (2)

4.3 "One can never conclusively prove paternity, one can only disprove paternity." Discuss the scientific truth of this statement. (3)

4.4 Give one other use for DNA fingerprinting besides settling paternity disputes. (1)

4.5 Ben is a minor and could not give consent for his DNA profile. Do you think it ethical that Patsy obtained his profile? Give reasons to support your answer. (3)

Answers

Exam Questions

Question 1

1.1 C
1.2 B
1.3 B

Question 2

2.1 In a DNA double helix, there are complimentary bases on each strand. This means that the number of bases A + G will always equal the number of bases T + C. (4)
2.2 In mRNA, there is only one strand, with no pairing between bases and therefore there is no reason why the proportion of bases is not 1:1. (2)
2.3 The fact that the squirrel and the shark have similar proportions of the four bases is irrelevant. It is the different sequence of bases in the two animal types that make them different. (2)

Question 3

3.1 X – Nucleus Y – ribosome (2)

3.2 1 – DNA 2 - mRNA 3 – t RNA (3)

3.3 7 – codon 8 – anticodon (2)

3.4 Transcription (1)

3.5 mRNA attaches to the Ribosome – Free tRNa molecules with their amino acids find their complementary codon on the MRNA - temporary bond - amino acids join in correct order - peptide bonds – to form a polypeptide/protein (5)

3.6

HIS –	LEU –	CYS –	GLY –	SER –	HIS –	LEU -	VAL	
mRNA	CAC	CUA	UGC	CGA	AGC	CAC	CUA	GUA
DNA	**GTG**	**GAT**	**ACG**	**GCT**	**TCG**	**GTG**	**GAT**	**CAT**

Question 4

4.1 Zak. He has more markers in common with Ben than Johnny

4.2 Advantage – responsible father can pay maintenance. disadvantage – father might not want anything to do with the child

4.3 The genetic markers only show a small piece of genetic material that if similar can prove paternity, if there are no similarities it can prove that their DNA is not similar thus they are not related

4.4 Criminal cases/unidentified bodies/poaching