Student Name: _____

BIOLOGY 2016

Unit 4
Key Topic Test 1 – DNA Replication and Protein Synthesis

Recommended writing time*: 45 minutes
Total number of marks available: 45 marks

QUESTION BOOK

* The recommended writing time is a guide to the time students should take to complete this test. Teachers may wish to alter this time and can do so at their own discretion.

Conditions and restrictions

- Students are permitted to bring into the room for this test: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the room for this test: blank sheets of paper and/or white out liquid/tape.
- No calculator is permitted in this test.

Materials supplied

- Question and answer book of 16 pages.

Instructions

- Print your name in the space provided on the top of the front page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the room for this test.

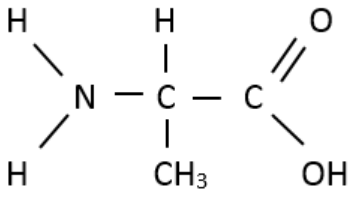
SECTION A – Multiple-choice questions

Instructions for Section A

Select the response that is **most correct** for the question. A correct answer scores 1, an incorrect answer scores 0. Marks are not deducted for incorrect answers. If more than 1 answer is completed for any question, no mark will be given.

Refer to the following information for questions 1 and 2

The following is an outline of four biological diagrams related to the production of a polypeptide through gene regulation.



I

II

III

IV

Question 1

Which of the following sequences correctly shows the diagrams in relation to the process of DNA code to polypeptide formation.

A. I, II, IV, III

B. III, IV, I, II

C. III, I, IV, II

D. I, IV, II, III

Question 2

Which of the following reactions allows the production of diagram II?

A. Catabolic
B. Hydrolysis
C. Dipeptide synthesis
D. Condensation polymerisation

Question 3

Which of the following correctly describes a TATA box.

A. An enzyme used to cleave DNA during transcription
B. A sequence of DNA that denotes a promoter region
C. The code found on the end of tRNA
D. The sequence of DNA code found in introns

Question 4

The polypeptide known as Haemoglobin is regulated through transcription and translation of the HBB gene. Mutations in the HBB gene can result in various diseases. One possible mutation that occurs within the peptide structure of Haemoglobin is sickle cell anemia. This occurs when Glutamic acid is replaced by Valine, due to the addition of or substitution of a single nitrogenous base. Which of the following is true of the function of Hemoglobin in people with this condition.

A. Differences in amino acid structure can result in abnormal folding of proteins
B. Changes in amino acids do not affect the overall function of proteins
C. Mutations in the HBB gene occur mainly during translation
D. Haemoglobin is only effected when changes to three nucleotide bases are substituted

Question 5

A nucleotide sequence containing 600 bases was translated to produce a regulatory protein involved in cellular enzyme activity. Which of the following may occur during the formation of this protein?

A. The final mRNA product contains 420 bases

B. 200 amino acids are found in this protein

C. Exons are removed from the pre-messenger RNA

D. Transfer RNA would carry 125 different amino acids to make this protein

Question 6

Which of the following correctly identifies the term genome?

A. The total sum of all genes present in an organism
B. A data base of all known genes from many organisms
C. The number of genes found in eukaryotic organisms
D. The number of chromosomes found within an organism

Question 7

In DNA:

A. Adenine is equal to the number of Guanine

B. There are always more phosphate groups than nitrogen groups

C. There are always more Guanine nucleotides than Cytosine nucleotides

D. There are equal numbers of phosphate groups to nitrogen groups

Question 8

Protease is an enzyme secreted from specialized cells within the stomach that are associated with digesting proteins into amino acids so that they can be absorbed into the blood stream. Which of the following would be found in the process of transcription and not in translation in the production of this enzyme?

A. Uracil
B. Amino acids

C. Introns

D. tRNA

Question 9

Which of the following is not a difference between DNA and RNA

A. Uracil in DNA is replaced with Thymine in RNA

B. DNA contains a deoxyribose sugar and RNA contains ribose sugar

C. DNA is a double stranded molecule and RNA is a single stranded molecule

D. DNA is found in the nucleus and RNA is found in both the cytosol and nucleus

Refer to the following diagram for question 10

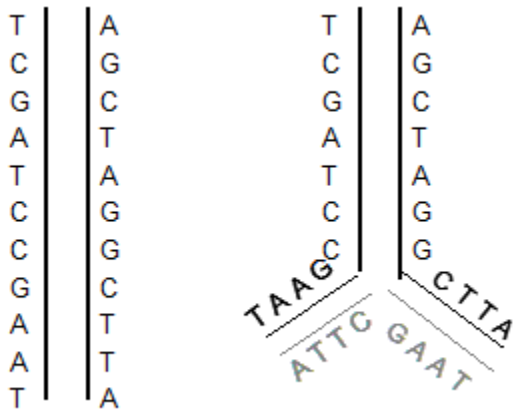


Figure 1 Figure 2

Question 10

Which of the following statements is correct about the diagram above.

A. Only figure 1 would require a single 3' and 5' end in order to function effectively.

B. Segments of DNA in figure 2 would be joined together using DNA polymerase

C. Okazaki fragments would be utilised in figure 2 and not figure 1.

D. The replication of figure 1 would require DNA ligase in order to separate the template from the complementary strand.

Question 11

Oncogenes are:

A. Genes that are not correctly turned on
B. Genes that interfere with normal signalling of transcription and translation
C. Genes that do not undergo pre mRNA modification
D. Genes that activate multiple genes within a chromosome at the same time

Question 12

Anticodons are found in which region of the cell?

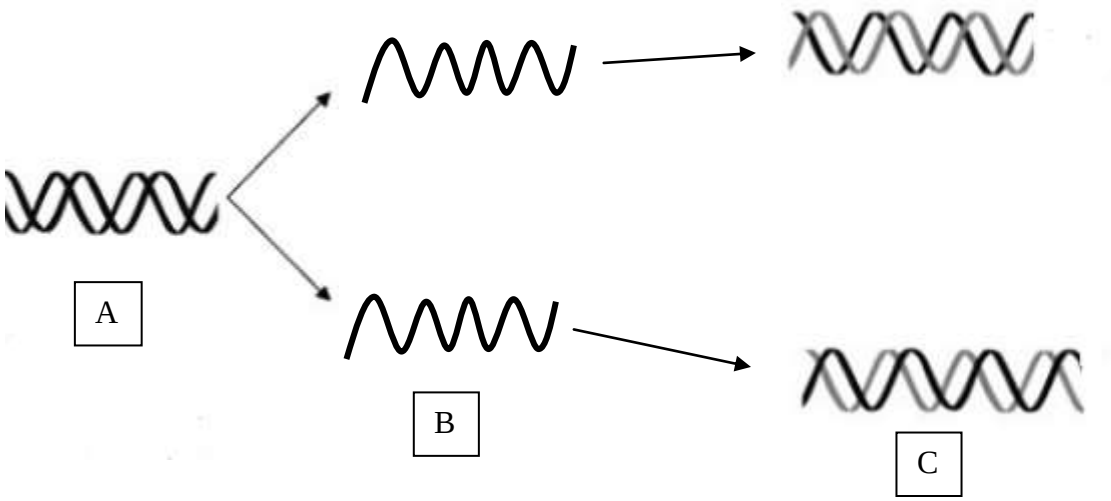
A. Nucleus
B. Ribosomes
C. Endoplasmic reticulum
D. Cytoplasm

SECTION B- Short-answer questions

Instructions for Section B
Answer all questions in the spaces provided.

Question 1 (5 marks)

The following is a simplistic diagram of DNA replication.



a. Outline the role of the following components in DNA Replication in relation to the three stages outlined above.

i. DNA Polymerase

_____

_____

ii. Replication fork

_____

_____

iii. DNA Helicase

_____

_____

iv. Nucleotides

_____

_____

1 + 1 + 1 + 1 = 4 marks

b. Why is this model referred to as semi conservative replication?

_____

_____

1 mark

Question 2 (11 marks)

A series of events are undertaken in order for a polypeptide to be produced from DNA. The polypeptides manufactured by the cell can be used for a variety of functions such as a component in the construction of cellular components or as a base for signalling molecules.

The following DNA sequence is a segment of DNA that is required to produce a particular polypeptide.

GTAGTACTGATTATATAGCCTGGGTA

a. Write the complementary mRNA sequence for this DNA.

_____

1 mark

b. Outline the series of steps that occur within the cell that produce the appropriate mRNA strand. Including any enzymes responsible for assisting this process.

_____

_____

_____

_____

_____

_____

3 marks

c. On the diagram below, label each end of the mRNA appropriately with the poly A tail and methyl cap.

1 mark

d. What is the name given to the series of steps outlined in part b?

_____

1 mark

The table below shows all codons and their respective amino acids.

	U		C		A		G		
	code	Amino Acid	code	Amino Acid	code	Amino Acid	code	Amino Acid	
U	UUU	phe	UCU	ser	UAU	tyr	UGU	cys	U
	UUC		UCC		UAC		UGC		C
	UUA	leu	UCA		UAA	STOP	UGA	STOP	A
	UUG		UCG		UAG	STOP	UGG	trp	G
C	CUU	leu	CCU	pro	CAU	his	CGU	arg	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	gln	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	ile	ACU	thr	AAU	asn	AGU	ser	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	lys	AGA	arg	A
	AUG	met	ACG		AAG		AGG		G
G	GUU	val	GCU	ala	GAU	asp	GGU	gly	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	glu	GGA		A
	GUG		GCG		GAG		GGG		G

e. Using the amino acid table provided, determine the amino acid sequence that would be produced.

_____

1 mark

f. Outline the series of events that occur within the cell that produce the appropriate amino acid sequence. Including any enzymes responsible for assisting this process.

_____

_____

_____

_____

_____

_____

3 marks

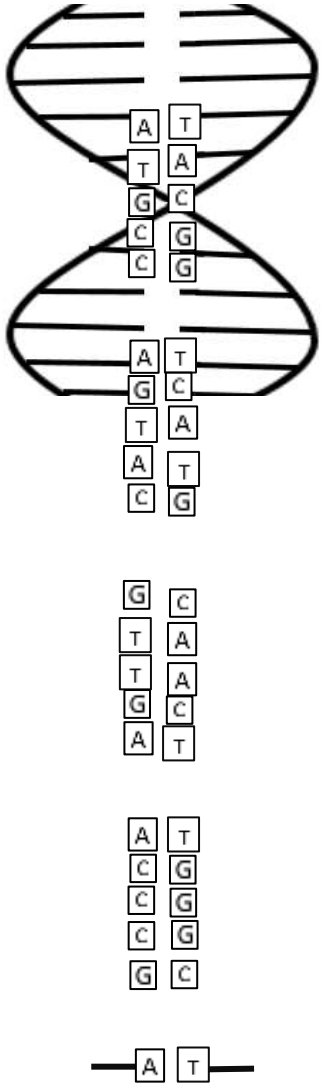
g. What is the name given to the series of steps outlined in part g?

_____

1 mark

Question 3 (6 marks)

The structure of proteins can be determined by the amino acid sequence that is derived from the DNA code. Consider the following segment of DNA in the questions below.



Strand A Strand B

a. Strand A is also known as the coding strand, at the top of it a phosphate molecule is found. Label the diagram with 3' and 5' ends. Then answer the following questions.

1 mark

b. What is strand B also known as?

_____

1 mark

c. Assuming that the DNA region shown is a coding region. Explain what would occur if the 15th nitrogenous base from the 5' end was replaced with a C. Include reference to its final functioning product.

_____

_____

_____

_____

2 marks

d. What type of mutation would part c be identified as?

_____

1 mark

e. What is the name given to the process where by a double stranded DNA molecule is split into two single strands?

_____

1 mark

Question 4 (7 marks)

An antibody is composed of proteins that are joined together to make a specific shape that can bind with antigens. Within a B-cell that differentiates into a plasma cell (the cell that produces antibodies), the immunoglobin gene carries hundreds of different regions that code for different types of antibodies to be produced. The genes are regulated based on exposure to specific pathogens.

a. Explain the term gene regulation.

_____

_____

_____

_____

2 marks

b. During the process of a specific type of antibody being produced, RNA splicing occurs.

i. Explain the process of RNA splicing.

_____

_____

_____

_____

2 marks

ii. What are the key differences between the segments that are produced as a result of part i?

_____

_____

_____

2 marks

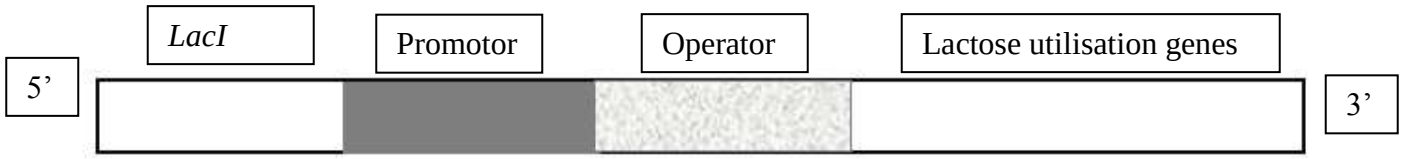
c. Prior to the gene segment that is used for the production of antibodies is a promoter region. What would be found within this region?

_____

1 mark

Question 5 (4 marks)

Lac operon, also known as lactose operon is commonly found in the DNA of *E.coli* bacterium. The genes code for the intake and breakdown of lactose in the cell to produce glucose and galactose. The operon has a few genes, it contains a promoter sequence and an operator sequence where transcription factor can bind. However, the Lac operon is usually switched off by a repressor protein binding to the transcription factor. This is shown in the diagram below.



Genetic modification is one application the Lac operon in function. The Lac operon is placed into yeast's genome along with green fluorescence protein (GFP) gene, which placed into the operator sequence at a specific site that is wished to be observed. The result is a glowing segment of chromosome under the microscope, which was used to determine how non-disjunction of chromatids occurs during cell replication.

a. Explain the role of the promoter sequence in this example.

_____

_____

_____

1 mark

b. Explain the role of the operator sequence in this example.

_____

_____

_____

1 mark

c. What must be present in this experiment in order for the GFP to be activated?

_____

_____

_____

1 mark

d. Explain the role of the repressor protein in this example.

_____

_____

_____

1 mark

END OF KEY TOPIC TEST