

Student Name: _____



BIOLOGY 2016

Unit 4

Key Topic Test 3 – Molecular Biology

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 13 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.

Question 1

Which of the following is not an agent used in PCR?

- A. Taq polymerase
- B. DNA helicase
- C. Oligonucleotide primers
- D. DNA polymerase

Question 2

The following DNA primers have been developed for use in a particular DNA technology.

3'GTAGCTAGCAA5' and 5'GGCCTTATATA3'

Which DNA strand below would be appropriate for these primers to work on?

- A. 3' GGCCTTATATACCCCGGGGTAGCTAGCAA5'
5' CCGGAATATATGGGGCCCCATCGATCGTT3'
- B. 3' CCGGAATATATCCCCGGGGTAGCTAGCAA5'
5' GGCCTTATATAGGGGCCCCATCGATCGTT3'
- C. 3' CCGGAATATATCCCCGGGGATCGATCGTT5'
5' GGCCTTATATAGGGGCCCCTAGCTAGCAA3'
- D. 3' CCGGAATATATCCCCGGGGATCGATCGTT3'
5' GGCCTTATATAGGGGCCCCTAGCTAGCAA5'

Question 3

Which of the following is incorrect of PCR?

- A. It is able to amplify specific regions of DNA
- B. It can produce mutations in the final DNA strands produced
- C. It utilises very small amounts of DNA
- D. It produces an image of DNA banding to determine fragment length

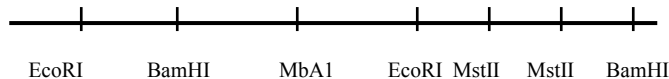
Question 4

In which of the following scenarios would a plasmid vector be useful?

- A. Inserting a human gene into a bacterial cell
- B. Amplifying DNA strands of a specific gene
- C. Identifying a criminal from a gel electrophoresis result
- D. In extending lengths of DNA during DNA hybridisation

Question 5

The diagram below represents a fragment of linear DNA and the restriction sites present in that DNA strand.



Which restriction enzyme should be used to produce the shortest fragment of DNA?

- A. EcoRI
- B. BamHI
- C. MstII
- D. MbaI

Question 6

What determines the action of restriction enzymes in cleaving DNA molecules?

- A. The length of the DNA strand
- B. The position and length of the PCR primers
- C. The sequence of bases that correspond to the restriction enzyme
- D. The addition of temperatures above 90°C to assist in breaking apart the DNA strands

SECTION B- Short-answer questions

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

Question 1 (12 marks)

A liger is the offspring of a male lion and female tiger. A specific segment of DNA from a liger, tiger and lion were analysed using DNA hybridisation techniques. The results are shown in the table below.

Test #	DNA strand A origin	DNA strand B origin	Percentage of relatedness found
1	Liger	Tiger	70%
2	Liger	Lion	60%
3	Lion	Tiger	40%
4	Lion	lion	100%
5	tiger	tiger	99.9%

a. What is a liger commonly known as in genetic studies?

1 mark

b. Explain the key steps in DNA hybridisation.

3 marks

- c. Explain how the experimenters determined that there was 40% relatedness between the tiger and the lion in test 3.

1 mark

- d. Explain how the experimenters determined that there was a 100% relatedness from the two lion samples in test 4.

1 mark

- e. Outline a possible reason as to why the two tiger samples were not a 100% match

1 mark

- f. Outline a possible reason as to why test 1 produced 70% and test 2 produced 60% despite a liger being a combination of both tiger and lion DNA.

1 mark

- g.** A Tigon is also a combination of a tiger and a lion, however, it is a combination of a male tiger and a female lion. Would similar or different results be found if many genetic studies were undertaken and their results averaged?

2 marks

- h.** It is known that in captivity a liger was successfully mated with a lion, a female tigon was mated with a lion and a female tigon was mated with a male tiger. All produced offspring, some of which were fertile. What does this suggest about the DNA of lions and tigers?

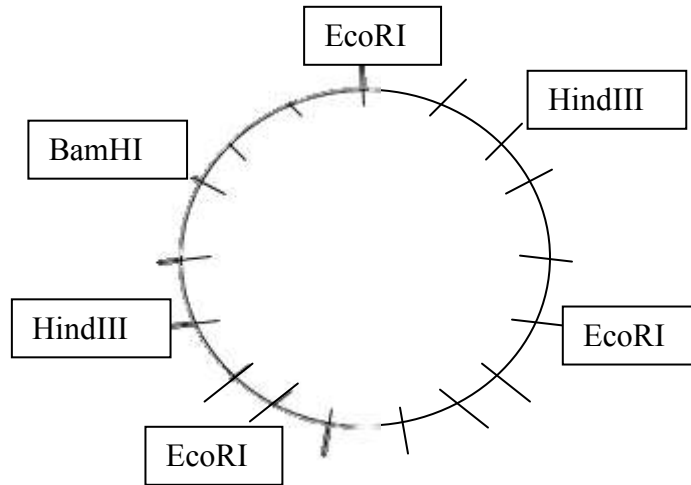
1 mark

- i.** Outline one limitation of the experimental data obtained in this experiment.

1 mark

Question 2 (8 marks)

The following chromosome has been taken from *Vibrio Cholerae* it is a single celled organism that is capable of reproduction and movement. The DNA contains a variety of restriction enzyme cutting sites as denoted by the linear marks on the diagram.



a. Is the organism prokaryotic or eukaryotic?

_____ 1 mark

b. Outline a key difference between circular DNA and linear DNA.

_____ 1 mark

- c. The restriction enzyme EcoRI has three recognition sites within the DNA. How many fragments of DNA will be produced as a result of this cleavage?

1 mark

- d. Name the two different types of cleavages that restriction enzymes can produce and outline which one is best in the ligation of new DNA strands.

3 marks

- e. Name a DNA technology that utilizes restriction enzymes.

1 mark

- f. Explain the significance of the restriction enzyme in the technology outlined in part e.

1 mark

Question 3 (19 marks)

Cystic fibrosis is a recessive genetic condition that results in increased mucous production in the lungs, liver and pancreas. It is apparent in most individuals that have two copies of a mutated allele which is of a shorter length to the normal allele due to the frame shift mutation that has occurred. It is approximately 189bp in length and the mutated version of the gene is around 110bp.

Two individuals that do not have cystic fibrosis are planning on having children in the near future. The female has a relative that died from cystic fibrosis at a young age in the 1970's and is concerned that she may also carry the gene for cystic fibrosis. They decide to undergo genetic testing to determine their chances of having a child with the condition. The Geneticist decides that gel electrophoresis is the most suitable test at this point in time and takes a small portion of blood from both future parents.

- a. After the DNA is isolated a procedure must be undertaken in order to amplify each of the samples.

i. Name this procedure

1 mark

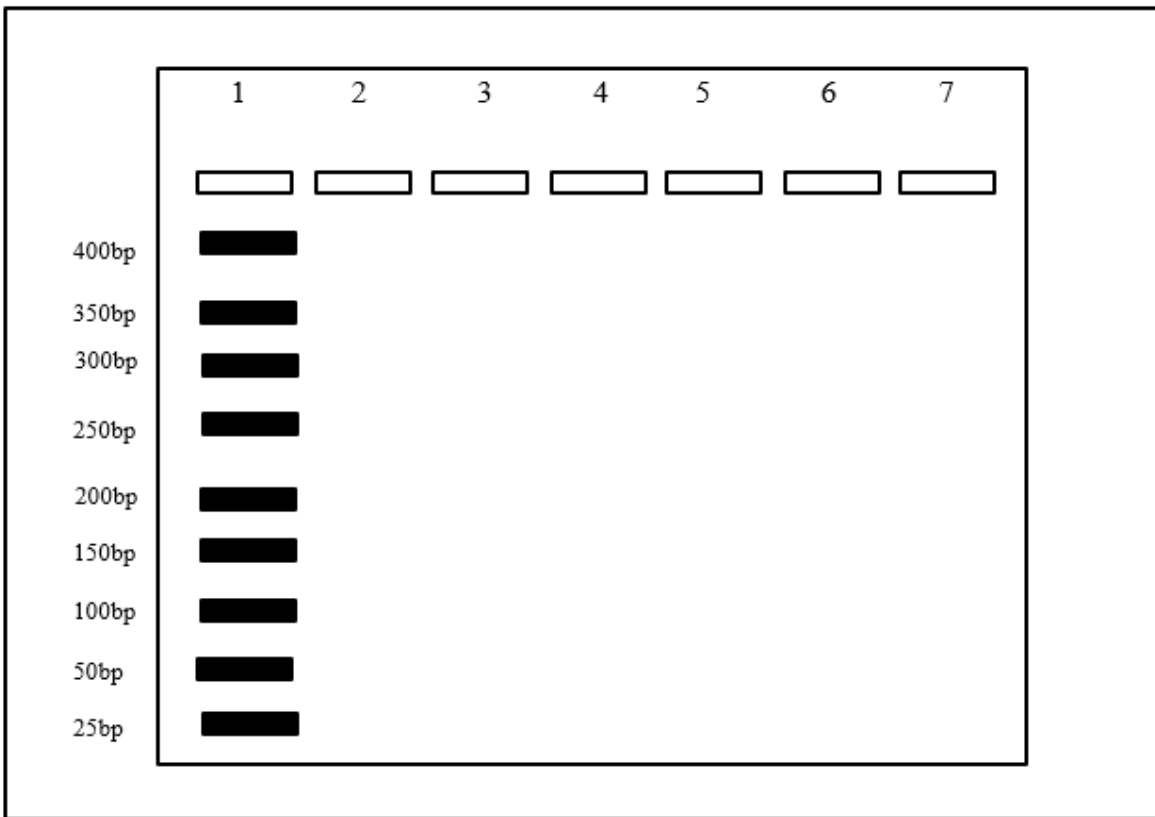
ii. Outline the importance of this procedure for use in the analysis of DNA.

1 mark

iii. Name one other use for this procedure.

1 mark

The amplified sample is then used in gel electrophoresis to determine the presence of specific genes for cystic fibrosis. *Below is a blank outline of the results.*



- b.** In lane 2 draw a band to indicate a homozygous individual without cystic fibrosis 1 mark
- c.** In lane 3 draw a band to indicate an individual with cystic fibrosis 1 mark
- d.** In lane 4 draw a band to indicate a heterozygous individual without cystic fibrosis 1 mark
- e.** Explain the relevance of lane 1. 1 mark

1 mark

f. What determines the position of the DNA in the gel?

2 marks

END OF KEY TOPIC TEST