Student Name: _____

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BIOLOGY 2017

Unit 4
Key Topic Test 4 – DNA manipulation

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 12 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

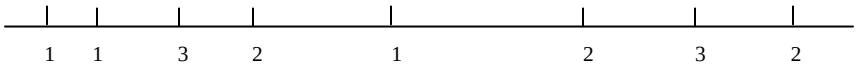
Polymerase chain reaction (PCR) is a method of DNA replication. Which of the following correctly identifies a similarity between natural DNA replication and artificial DNA replication? Both processes:

- **A.** Only occur in living cells.
- **B.** Involve the unwinding of DNA by DNA helicase.
- **C.** Produce billions of copies of DNA from a single template.
- **D.** Involve template strands of DNA being read by DNA polymerase.

Question 2

It is common for there to be recognition sites for several different restriction enzymes in a piece of DNA, such as the piece shown below. The numbers underneath the line indicate the recognition site for each enzyme.

1 is Hind III 2 is Pov I 3 is EcoRI



Which of the following statements is correct?

- **A.** The smallest fragment would be produced by using EcoRI only.
- **B.** The largest number of fragments would be produced by using PovI only.
- **C.** If PovI and HindII were used together then seven fragments would be produced.
- **D.** If HindIII and EcoRI were used together then five fragments would be produced.

Question 3

Which of the following correctly identifies the role of a vector in the process of transformation? A vector is:

- **A.** A plasmid into which foreign DNA has been placed.
- **B.** A bacterium into which foreign DNA has been inserted.
- **C.** A bacterium which causes an infectious disease in a host.
- **D.** A bacteriophage in which all harmful DNA has been removed from.

Question 4
Which of the following enzymes are used to anneal a section of foreign genetic material into a plasmid?

A. Ligase
B. Ligation
C. DNA ligase
D. RNA ligase

Question 5
Most restriction enzymes are designed to cut DNA so that:

A. Identical sticky ends are produced at each end of the DNA.
B. Blunt ends are produced at each end of the DNA.
C. Complementary sticky ends are produced at each end of the DNA.
D. A single strand of DNA is produced from the original double strand.

Question 6
When carrying out gene cloning the role played by DNA ligase is to:

A. Act as a probe used to identify foreign DNA.
B. Act as a sealing agent to anneal two pieces of DNA together.
C. Act as a cutting agent in order to produce two pieces of DNA with complementary ends.
D. Act as a mutagenic agent so that bacteria with recombinant DNA can be easily identified.

Question 7
Gel electrophoresis is a technique which is used to sort separate fragments of DNA. The extent to which a DNA fragment moves through a gel is determined by:

A. The size of the DNA fragment.
B. The number of copies of the DNA.
C. The charge of the fragment of DNA.
D. The base sequence of the fragment of DNA.

Question 8
Which of the following best identifies the importance of bacteria in gene cloning?

A. They reproduce very quickly.
B. They are all genetically identical to each other.
C. They are used to produce the enzymes used in gene cloning.
D. They are able to take up and copy plasmids containing foreign DNA.

Question 9
Which of the following is the best definition of a plasmid? A plasmid is:

- **A.** An example of transgenic bacteria.
- **B.** A circular piece of DNA originating in bacteria.
- **C.** A clone of a bacterium that has been genetically modified.
- **D.** An enzyme produced by bacteria used as a defence mechanism against moulds.

Question 10
The enzyme used during PCR is known as:

- **A.** Taq polymerase.
- **B.** DNA polymerase.
- **C.** RNA polymerase.
- **D.** Copy polymerase.

SECTION B - Short-answer questions

Instructions for Section B

Answer all questions in the spaces provided.

Question 1 (10 marks)

Beginning in 1996 the FBI launched a national DNA database known as CODIS. The database stores information relating to 13 specific loci which have variable numbers of short tandem repeat sequences (STRs). One of these is the CSF1PO locus which has between six and fifteen repeats of the AGAT tetranucleotide.

a. Prior to analysis, genetic samples are amplified using PCR. Briefly identify the three stages of PCR and explain what occurs during each stage.

3 marks

b. Why is PCR carried out prior to analyzing a DNA sample?

1 mark

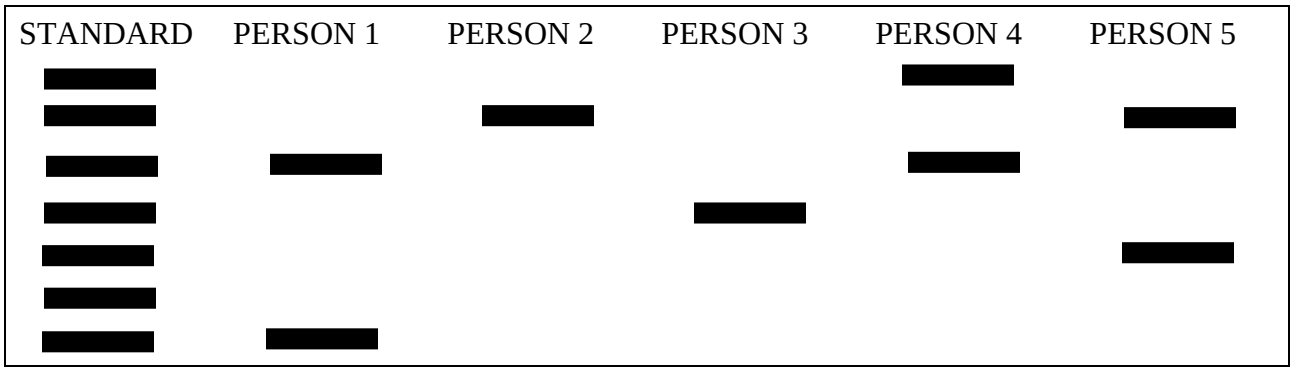
c. Identify an enzyme which carries out a function in DNA replication, but is not used in a PCR mix. Explain why this enzyme is not used during PCR.

2 marks

d. After amplification DNA is separated using gel electrophoresis. Identify two properties of DNA which enables it to be separated using this process.

2 marks

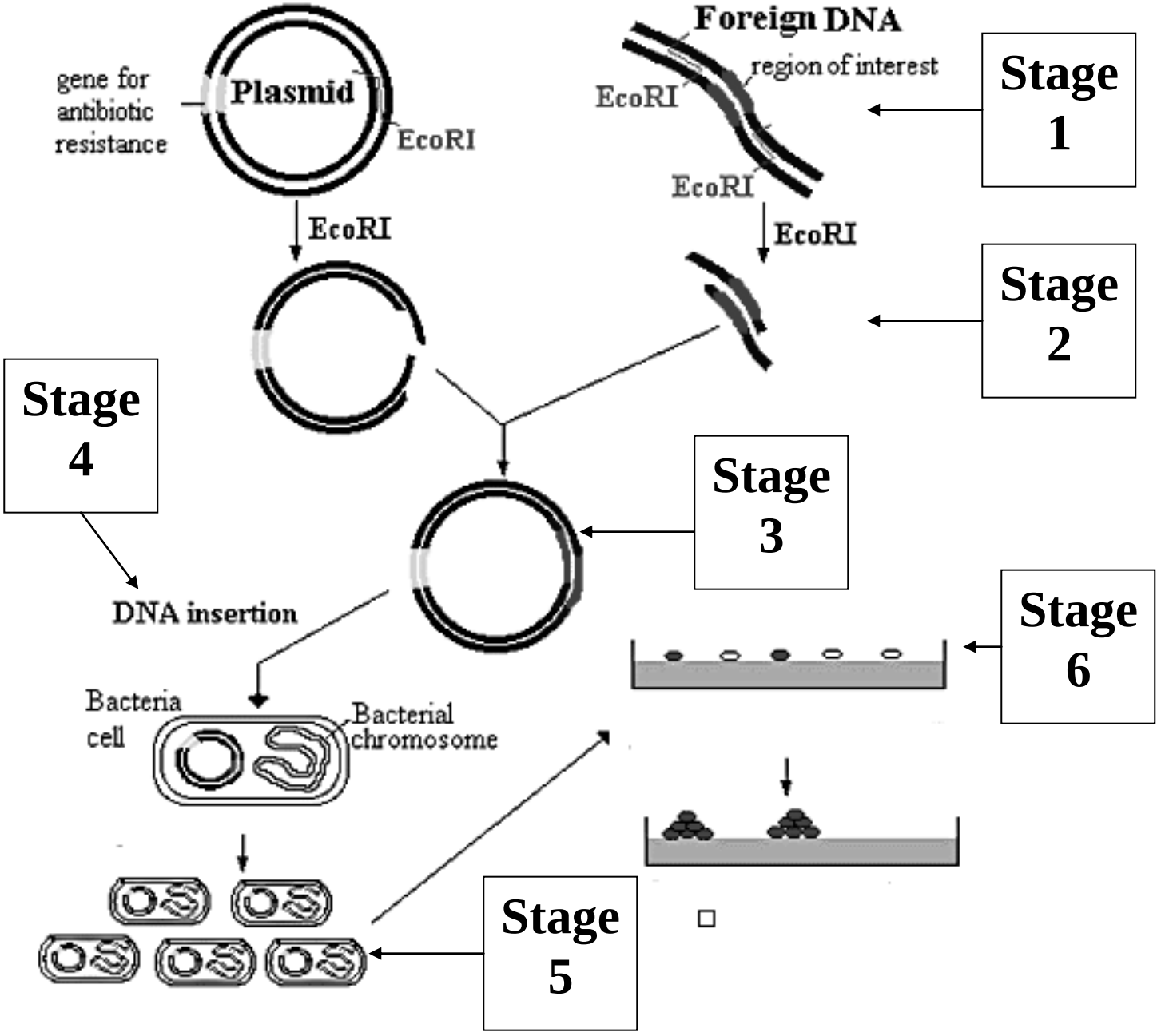
The following diagram shows an example of an electrophoresis gel containing samples from five different people. The DNA of each person would have been inserted into a well at the top of the diagram.



e. Which individual has the variation with the most STR regions? Provide a reason to support your answer.

2 marks

Question 2 (14 marks)
The diagram below shows an overview of the process of transformation using a bacterial vector. Use the information from this diagram and your knowledge to answer the following questions.



a. What is EcoRI? What is its function?

2 marks

b. Why is EcoRI shown in conjunction with both the plasmid and the foreign DNA?

1 mark

c. What is the purpose of including a gene for antibiotic resistance in the plasmid shown in stage 1?

1 mark

d. Identify the type of ends shown on the plasmid and the gene of interest at the end of stage 2.

1 mark

e. A different type of end may be produced at the end of this stage. What is the name of this other type of end? Which is the best type of end to produce? Provide a reason to support your answer.

3 marks

f. What term is used to describe the plasmid that shown at the end of stage 3? Why is it called this?

2 marks

g. What term is used to describe the bacteria produced at the end of stage 5? What does this term mean?

2 marks

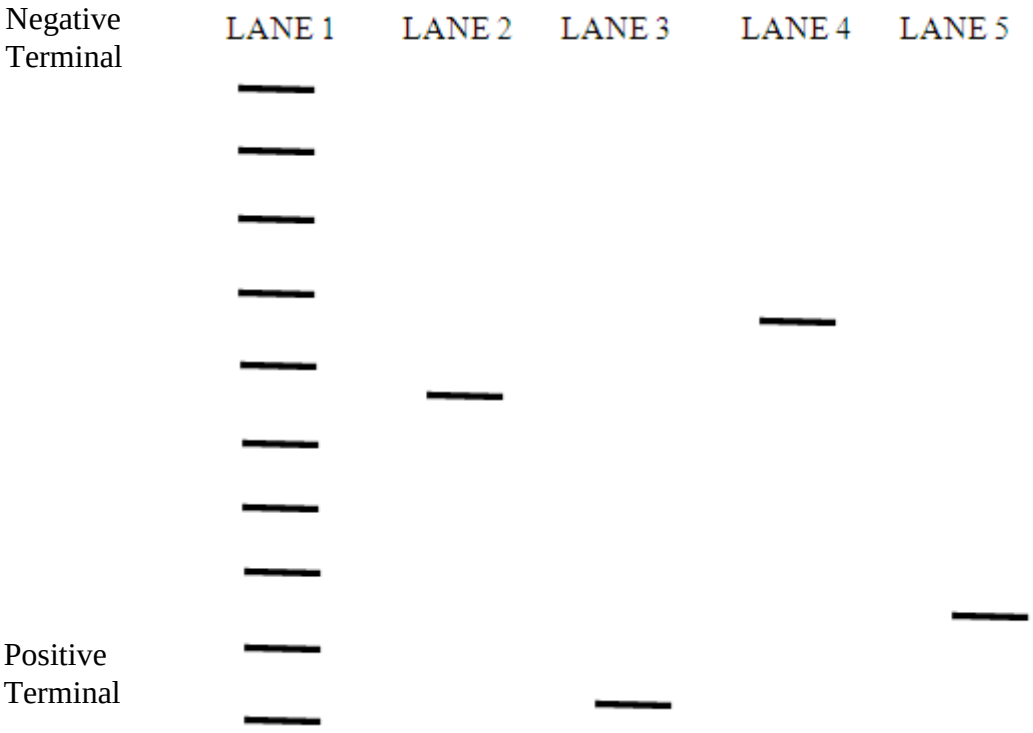
h. At the start of stage 6 the bacteria on the agar are represented by two different colours. However, at the end of stage 6 the bacteria are represented by a single colour. Explain what has occurred, referring to any causative agent in the agar in your answer.

2 marks

Question 3 (11 marks)
When performing electrophoresis a DNA standard solution is always used. In this case, the standard is in lane 1 of the diagram below.

The manufacturers have provided the following information about the standard solution. "The standard solution is a stock solution consisting of 10 DNA fragments ranging in size from 1.5kb to 16kb**.** Each fragment differs in size from the next by 1.5kb".

The diagram below represents an electrophoresis gel. Lane 1 contains the marker solution and the other 4 lanes contain samples to be identified. In this example, the people carrying out the procedure are using a plasmid that is 8kb long and a gene insert that is 2kb long.



a. Write the size of each fragment in the standard solution next to the appropriate position in lane 1.

1 mark

b. Explain the purpose of using a standard solution when performing electrophoresis

1 mark

c. Although marker solutions are very useful there are also limitations to the information that can be gained by their use. Use the bands on the gel diagram provided to identify AND explain a limitation of marker solutions.

2 marks

d. Based on the information provided, identify which lane contains the plasmid that was cut open, which lane contains the gene insert and which lane contains the plasmid and gene insert combined together. Use the data to assist you to provide a reason for each of your choices.

6 marks

e. The researchers wish to produce a bacterium that is capable of expressing the gene insert. Explain why the process of gel electrophoresis needed to be performed in order to achieve this goal.

1 mark

END OF KEY TOPIC TEST