



PAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, NATURAL RESOURCES AND APPLIED SCIENCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

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COURSE CODE: BIO701S	COURSE NAME: BIOTECHNOLOGY
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SECOND OPPORTUNITY/SUPPLEMENTARY EXAMINATION QUESTION PAPER	
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INSTRUCTIONS
<ol style="list-style-type: none">1. Answer ALL the questions.2. Write clearly and neatly.3. Number the answers clearly.

THIS EXAMINATION PAPER CONSISTS OF 7 PAGES (Excluding this front page)

Section A: Multiple choice questions (15 marks)

1. If mRNA is complementary to the DNA template strand and the DNA template strand is complementary to the DNA non-template strand, why are base sequences of mRNA and the DNA non-template strand not identical? Could they ever be?
 - A. No, they cannot be identical because the T nucleotide in DNA is replaced with U nucleotide in RNA and AUG is the start codon.
 - B. No, they cannot be identical because the T nucleotide in RNA is replaced with U nucleotide in DNA.
 - C. They can be identical if methylation of the U nucleotide in RNA occurs and gives T nucleotide.
 - D. They can be identical if de-methylation of the U nucleotide in RNA occurs and gives T nucleotide.

2. In gel electrophoresis of DNA, the different bands in the final gel separate because the DNA molecules
 - A. Are from different organisms
 - B. Have different lengths
 - C. Have different nucleotide compositions
 - D. Have different genes

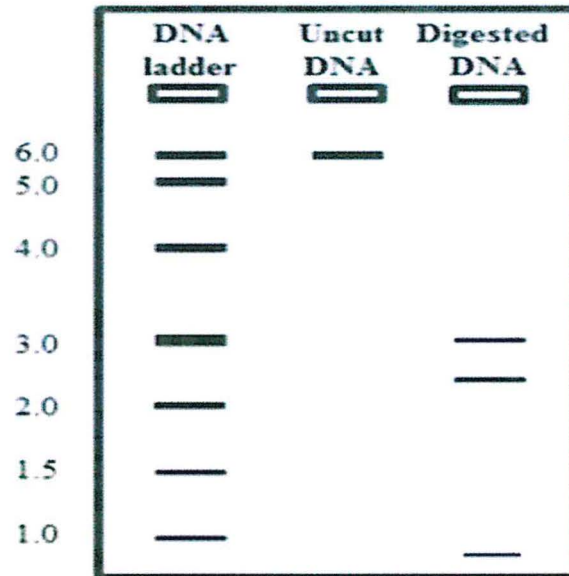
3. The goal of a PCR reaction is to
 - A. Separate DNA based on fragment size
 - B. Determine a DNA profile
 - C. Produce copies of a targeted DNA region(s)
 - D. None of these answers
 - E. Sequence a DNA template region(s)

4. Which statement defines cloning?
 - A. Making offspring identical to one parent.
 - B. Producing identical plants and animals by natural or artificial means.
 - C. Producing genetically identical copies of an individual, cell or gene.
 - D. Splitting embryos to make twins.

5. A researcher is performing PCR to amplify a sample of DNA. Unfortunately, he forgot to add the DNA primer prior to starting the experiment. Which of the following results is he most likely to observe?

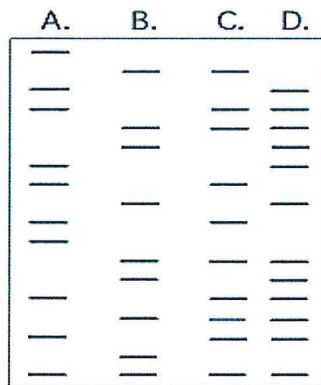
- A. The reaction will work, but at a significantly slower rate
 - B. The reaction will work, but the product will contain many undesired mutations
 - C. The reaction will be completely unsuccessful
 - D. The reaction will work, but amplify a region that was not his target
6. Polymerase chain reaction (PCR) employs a heat-stable polymerase, such as Taq polymerase, to assemble the amplified strand of DNA. Which of the following best describes why heat-stable polymerases are ideal for PCR?
- A. PCR requires thermal cycling, and heat-stable polymerases can be inactivated when they are not needed during the low temperature phases.
 - B. Heat-stable polymerase cannot break the double-stranded DNA unless the temperature is very high, thus requiring heat-stable polymerases
 - C. The interaction between bivalent cations and polymerases is most efficient during high temperature phases, thus requiring heat-stable polymerase
 - D. PCR requires thermal cycling, and heat-stable polymerases will neither denature nor lose efficacy in DNA synthesis during the high-temperature cycle.
 - E. Heat-stable polymerases are typically much cheaper than normal polymerases and are therefore more suited to large scale laboratory amplification of DNA
7. Why are yeast cells frequently used as hosts for cloning a gene for production of human protein?
- A. They easily form colonies
 - B. They can remove exons from mRNA
 - C. They do not have plasmids
 - D. They are eukaryotic cells
8. After four cycles of thermocycling, how many copies of the targeted region will be in the PCR product?
- A. 8
 - B. 16
 - C. 32
 - D. 64
9. What would be the effect on the PCR reaction if any of the following circumstances arose: 1) there are no dNTPs in the reaction, 2) there is no Taq polymerase in the reaction?
- A. PCR would proceed normally
 - B. Non-specific PCR of random templates will occur

- C. The reaction will cease after a few cycles
 - D. The PCR reaction will not commence
10. The following image represents the agarose gel results from the restriction digest of a 6 kb piece of DNA that possesses two restriction sites. Which of the following statements is true?



- A. The restriction digest was incomplete because the smallest DNA band is missing.
 - B. It is impossible to determine if the digest was successful.
 - C. The piece of DNA that was digested was not 6 kb long.
 - D. The 6 kb piece of DNA was completely digested by the restriction enzyme.
 - E. Two of the statements are true.
11. What is the major challenge in the production of RNA in eukaryotes compared to prokaryotes?
- A. Exporting the mRNA across the nuclear membrane
 - B. Importing the mRNA across the nuclear membrane
 - C. The mRNA staying inside the nuclear membrane
 - D. The mRNA translating into proteins within seconds
12. Which of the following method would you use to analyse gene expression changes?
- A. Agarose gel electrophoresis
 - B. Southern blotting
 - C. Northern blotting
 - D. Calcium chloride transformation

13. The DNA profiles below represent four different individuals.



Which of the following statements is consistent with the results?

- A. B is the child of A and C
- B. C is the child of A and B
- C. D is the child of B and C
- D. A is the child of B and C
- E. A is the child of C and D

14. Yeast artificial chromosomes contain which of the following elements?

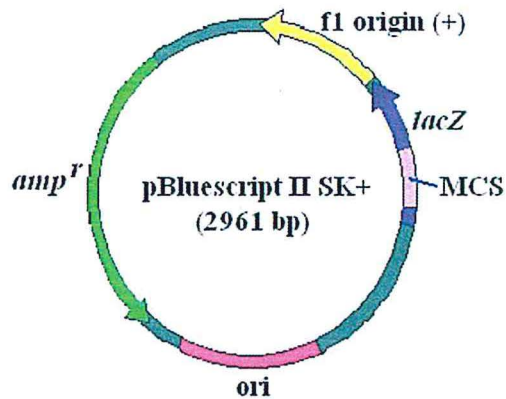
- A. Centromere only
- B. Telomeres only
- C. Origin of replication only
- D. Centromeres and telomeres only
- E. Centromere, telomeres and an origin of replication

15. Why does the restriction phenomenon in bacteria naturally occur?

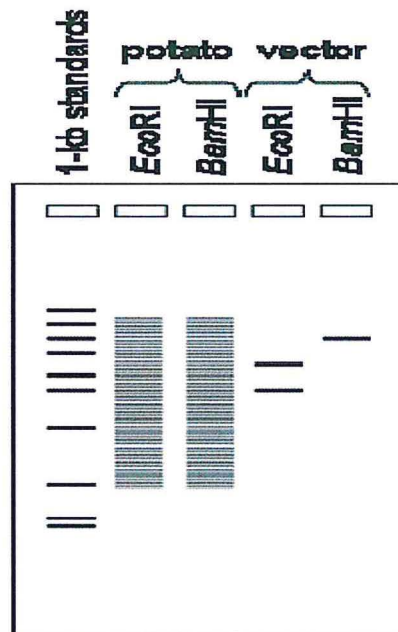
- A. For efficient cloning
- B. Bacteria produce an enzyme
- C. Destruction of bacterium's own DNA
- D. For survival

Section B: Answer all questions (85 Marks)

1. Developing nations like Namibia are now taking steps to build long-term plans to benefit from biotechnology innovation and harness the potential of this field for economic development and addressing societal problems.
Write to the President of Namibia, giving examples on how biotechnology can be used to improve the livelihood of people in Namibia. (20)
2. As part of your work with the Ministry of Health and Social Services, you are required to produce COVID-19 vaccine in tobacco (*Nicotiana bethamiana*).
 - a. Outline with aid of diagrams, an experimental strategy that you will use to develop COVID-19 vaccine in tobacco through genetic engineering. (10)
 - b. What are advantages of producing recombinant in plants instead of bacterial cells. (4)
 - c. What is the difference between a selectable marker and reporter gene? Give examples. (3)
 - d. Detail the critical components of the growth medium that will be used to select for bacteria cells that contains the recombinant plasmid containing the vaccine gene.
Explain how? (2)
 - e. Tetracycline is an antibiotic. Some scientists are concerned about the gene for resistance to kanamycin being present in maize which is released into the environment. Suggest why? (2)
 - f. Instead of using an antibiotic as a selectable marker, suggest any other safe alternative method for screening transformants (1)
3. Discuss some strategies that you can use to purify a recombinant protein produced in a prokaryotic host. (3)
4. Describe with the aid of diagrams how DNA can be used to identify a crime aspect.
Illustrate your answer by well labelled diagrams (10)
5. Ms Lydia, a recent graduate in biotechnology gets so excited about genetic engineering concepts she learnt in BIO702S and wants to clone DNA extracted from potato leaves in pBluescript 11SK shown below plasmid.



Firstly, she grinds up some potato tissues, extracts the DNA from it and digests the DNA with two different restriction enzymes (separately, not together): *EcoRI* and *BamHI*. She then obtains a cloning vector pBluescript 11SK and digests it with the same two enzymes. She then runs a gel, which is shown below.



- What are the key characteristics that plasmid pBluescript 11SK have that it can be used for successful cloning (4)
- Why is it important for this plasmid to have an ampicillin-resistance gene? (3)
- Which enzyme would she use for cloning the potato DNA: *EcoRI*, or *BamHI*? Explain why you made your choice. (3)

- d. Notice that the cloning vector made nice, tight bands on the gel, but the potato DNA just looks like a smear with no distinct bands. However, this is just what the Ms Lydia was expecting, so she's not worried about it at all. Explain why this is the expected result. (2)
- e.
- f. Ms Lydia now mixes the potato DNA (digested with the enzyme you specified in part A) with cloning vector DNA (digested with the same enzyme). He then adds the mixture to *E. coli* cells that have been treated with CaCl₂, heats briefly to 42°C, adds growth medium and incubate if for an hour. What would be his next step? Be as specific as possible. (2)
- g. Unfortunately, after doing the next step as you specified, Ms Lydia doesn't get a single bacterial colony. Not even one! When she reviews his procedure, she realizes she left out a critical step. What did he forget, and why would this be necessary? (2)

6. Write short notes on

- i. Namibia's Biosafety Act (3)
- ii. Precautionary principle? (2)
- iii. Terminator gene technology (2)
- iv. The Cartagena Protocol on Biosafety (3)

7. Recombinant DNA technology tools and techniques have been copied from nature. Discuss this statement giving at least four (4) relevant examples (4)

