NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY
FACULTY OF HEALTH, NATURAL RESOURCES AND APPLIED SCIENCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION : BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BSC	**LEVEL:** 7
COURSE CODE: BIO701S	**COURSE NAME:** BIOTECHNOLOGY
DATE: NOVEMBER 2022	
DURATION: 3 HOURS	**MARKS:** 100
FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	DR NORMAN MUZHINJI
MODERATOR:	DR J. D. UZABAKIRIHO

INSTRUCTIONS

1. All examination **RULES** apply
2. Answer ALL the questions.
3. Write clearly and neatly.
4. Number the answers clearly.
5. All written work **MUST** be done in **BLUE** or **BLACK** ink.

PERMISSIBLE MATERIALS

1. Examination question paper
2. Answering book

THIS QUESTION PAPER CONSISTS OF 4 PAGES (Excluding this front page)

Section A: Multiple choice (10marks)

1. Which enzyme is used for gene editing?
   A. CRISPR-Cas 9
   B. DNA ligase
   C. Hexokinase
   D. Acetyl transferase

2. Which of the following court ruling made DNA patentable?
   A. Diamond vs. Chakrabarty
   B. Brown vs. Board of Education
   C. Scopes monkey trial
   D. Roe vs. Wade

3. Which sequence of events occurs in the process of making genetically modified bacteria
   A. Extraction of required gene and plasmid→ Ligating the gene and plasmid → Insertion of plasmid into bacterial cells → Growth of transformed bacterial cells
   B. Growth of transformed bacterial cells → Insertion of plasmid into bacterial cells → Extraction of required gene
   C. Insertion of plasmid into bacterial cells → Growth of transformed bacterial cells → Extraction of required gene
   D. Extraction of plasmid into bacterial cells→ Extraction of plasmid→ Growth of bacterial cells
4. What enzyme forms covalent bonds between restriction fragments?
   A. DNA primase
   B. DNA helicase
   C. DNA ligase
   D. DNA polymerase
5. What are the typical characteristics of a cloning vector?
   A. Bacterial cells cannot survive without it when grown under certain conditions.
   B. It contains restriction sites that allow the insertion of foreign DNA segments.
   C. It can replicate in bacterial cells.
   D. All of the above.
6. In order to insert a human gene into plasmid, both must
   A. Code for the same gene product.
   B. Be cut by the same restriction enzyme.
   C. Originate from the same type of cell.
   D. Have identical sequences
7. What is the role of *Agrobacterium tumefaciens* in the production of transgenic plants?
   A. Genes from *A. tumefaciens* are inserted into plant DNA to give the plant different traits.
   B. Transgenic plants have been given resistance to the pest *A. tumefaciens*.
   C. *A. tumefaciens* is used as a vector to move genes into plant cells.
   D. Plant genes are incorporated into the genome of *Agrobacterium tumefaciens*

8. The process of converting environmental pollutants into harmless products by naturally occurring microbes is called
    A. Exsitu bioremediation
    B. Intrinsic bioremediation
    C. Extrinsic bioremediation
    D. None of the above

9. Which of the following choices best represents the phenotype of a cell containing a mutation in the *Lac I* gene?
    A Constitutive expression of the lac operon
    B No expression of the operon; RNA polymerase cannot bind properly
    C Lactose can enter the cell, but cannot be broken down
    D Lactose cannot enter the cell

10. Which of the following method would you use to analyse protein expression changes?
    A. Agarose gel electrophoresis
    B. Western blotting
    C. Northern blotting
    D. Calcium chloride transformation

SECTION B: Answer all questions (90 Marks)

1. Biotechnology is a recent science gaining functionality only within the past two decades. State True or False and justify your answer: (2)

2. Recombinant DNA technology tools and techniques have been copied from nature. Discuss this statement giving at least five (5) relevant examples (5)

3. Compare and contrast
   a. Recombinant DNA technology and gene editing (4)
   b. In-situ and ex-situ bioremediation (2)

5. a. Given the sequence below, design the forward and reverse primers, each 18 nucleotides long, which would allow you to generate many copies of a PCR product that was 400 base pairs long. (2)

```
      GGACCGCGGGGCAGGATTGCTCCGGGCTGTTTCATGACTTGTCAGGTGGGATGACTTGGATGGAAAAGTAGAAGGTCATG
    1 +---------+---------+---------+---------+---------+---------+---------+---------
      CCTGGCGCCCCGTCCTAACGAGGCCCGACAAAGTACTGAACAGTCCACCCTACTGAACCTACCTTTTCATCTTCCAGTAC

      GGGTGGCCAACTTGGGCGAGAAAAGGTATATAAAGGTCTCTTGCTCCCATCAACTGCCTCAAAAGTAGGTATTCCAGCAG
   81 +---------+---------+---------+---------+---------+---------+---------+---------
      CCCACCGGTTGAACCCGCTCTTTTCCATATATTTCCAGAGAACGAGGGTAGTTGACGGAGTTTTCATCCATAAGGTCGTC

      ATCAGACAACGTCAGGTGGGAGGACTTGGACGGAAAAGTAGAAGGTCAAGACCAACCTCTTCCAATCCAACCACAAACAA
  161 +---------+---------+---------+---------+---------+---------+---------+---------
      TAGTCTGTTGCAGTCCACCCTCCTGAACCTGCCTTTTCATCTTCCAGTTCTGGTTGGAGAAGGTTAGGTTGGTGTTTGTT

      AAAATCAGCCAATATGTCCGACTTCGAGAACAAGAACCCCAACAACGTCCTTGGCGGACACAAGGCCACCCTTCACAACC
  241 +---------+---------+---------+---------+---------+---------+---------+---------
      TTTTAGTCGGTTATACAGGCTGAAGCTCTTGTTCTTGGGGTTGTTGCAGGAACCGCCTGTGTTCCGGTGGGAAGTGTTGG

      CTAGTATGTATCCTCCTCAGAGCCTCCAGCTTCCGTCCCTCGTCGACATTTCCTTTTTTTTCATATTACATCCATCCAAG
  321 +---------+---------+---------+---------+---------+---------+---------+---------
      GATCATACATAGGAGGAGTCTCGGAGGTCGAAGGCAGGGAGCAGCTGTAAAGGAAAAAAAAGTATAATGTAGGTAGGTTC
```

   b. What is the function of primers? (2)
   c. After you have designed your primers, you want to use them in a PCR reaction. What is a polymerase chain reaction? What are the steps involved? Mention its applications. (10)
   d. Now, you want to view the DNA that you have PCR amplified using gel electrophoresis, explain how you would prepare 150 mls of 3% agarose gel for doing your electrophoresis? (2)
   e. You run your DNA fragments on an ethidium bromide-stained agarose gel, but no bands were observed. What do you think would be the cause? (3)

6. Eva-Lisa, a scientist at the Biotechnology Research Center digested a pUC19 plasmid using EcoR1 and HindIII, both enzymes are super imposed together i.e. double digest. Using the information on the table below.

Restriction enzyme	Number of base pair per band			
EcoR1	30	15	5	
Hind III	50			
EcoR1 +Hind III	20	15	10	5

Using a well labelled diagram, show where these enzymes cut the plasmid. (8)

7. ***Resurrecting*** plant is an extraordinary plant, that can survive in the hot, dry desert where other plants can't survive. On the other hand, food crops have little to no drought resistance or tolerance. The Minister of Agriculture, Water and Forestry has hypothesized that putting resurrecting plant's survival skills into maize will make it drought tolerant and expand cultivation of maize to marginal arid areas of Namibia.
   Imagine, you have been engaged by the Minister of Agriculture, Water and Forestry as a scientist to make use of the ***Resurrecting*** plant surviving skills to develop a maize variety that is drought tolerant,

   a. With the aid of a diagram, detail all the steps to the Minister on how you would intend to come up with such a maize variety (17)
   b. Mention any three vector-less methods that you can use to introduce recombinant DNA into a competent host cell. (6)

8. A gene was being ligated to the plasmid vector to prepare a recombinant DNA during bacterial transformation. An exonuclease was added to the tube accidentally. How will it affect the next step of the experiment? (2)

9. The development of genetically engineered plants has been a topic of debate for over three decades now. Describe the benefits, advantages of developing GMO crops and detail how you can mitigate the risks posed by GMO crops? (15)

10. Write short notes on

   i. Terminator gene technology (2)
   ii. The Cartagena Protocol on Biosafety (3)
   iii. Central Dogma of Molecular Biology (3)
   iv. Gene therapy (2)