

BIOTECHNOLOGY

21000074

PAPER 1 (THEORY)

Maximum Marks: 70

Time Allotted: Three Hours

Reading Time: Additional Fifteen Minutes

Instructions to Candidates

1. You are allowed an **additional fifteen minutes** for **only** reading the question paper.
2. You must **NOT** start writing during reading time.
3. This question paper has **11 printed pages and one blank page**.
4. There are **twelve** questions in the paper. All questions are compulsory.
5. There are **three** sections in the paper: **A, B and C**.
6. **Section A** has **ten subparts** which are very short answer questions. Each question carries 1 mark.
7. While answering **Multiple Choice Questions** in Section A, you are required to write **ONLY** one option as the correct answer.
8. **Section B** has **seven questions** which are short answer questions. Each question carries 4 marks.
9. **Section C** has **four questions** which are long answer questions. Each question carries 7 marks.
10. **Internal choices** have been provided in **two questions** in **Section B** and in **one question** in **Section C**.
11. The intended marks for questions are given in brackets [].

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Instruction to Supervising Examiner

1. Kindly read **aloud** the Instructions given on page 1. to all the candidates present in the examination hall.
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SECTION A – 14 MARKS

Question 1

- (i) During DNA replication, helicases break the hydrogen bonds between the complementary bases of two strands to separate the DNA strands. These DNA strands can rejoin if a specific protein is absent. [1]

Name the proteins that keep the DNA strands apart during replication.

- (ii) Using the protocol of Messelson-Stahl experiment, a DNA molecule is subjected to replicate for three cycles. [1]

What would be the percentage of heavy nitrogen detected in the penultimate generation?

- (iii) A researcher uses pBR322 to transfer the desired gene in *E.coli* and observes that some colonies grow only on ampicillin but not on tetracycline medium. [1]

This indicates:

- (a) No transformation in *E.coli*
(b) Gene insertion at ampicillin site
(c) Gene insertion at tetracycline site
(d) No recombination formation in *E.coli*
- (iv) Given below are the main steps involved in DNA profiling. [1]

S.No.	Steps
A	PCR
B	VNTR probe
C	Electrophoresis
D	Autoradiography
E	Isolation of DNA
F	Southern Blotting

Arrange the above steps in correct sequence followed during DNA profiling.

- (v) Give a reason for each of the following:

- (a) An RNA primer is required during DNA replication. [1]
(b) Dimethyl sulphoxide is used to preserve the pollen grains in liquid nitrogen. [1]

- (vi) Observe the following mRNA sequence and the aminoacylated tRNAs shown in **Figure 1**.

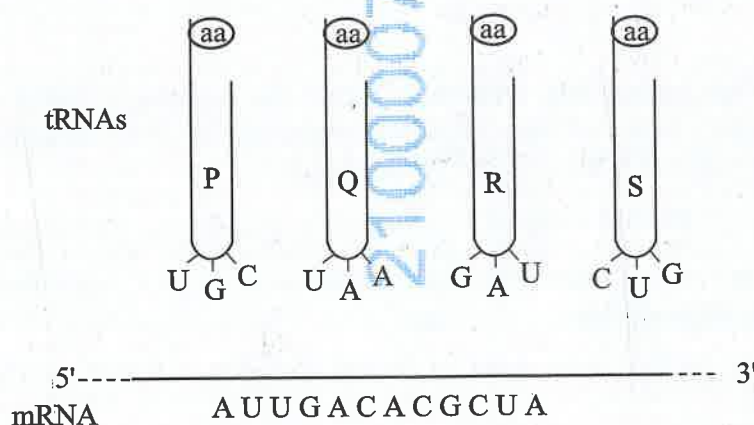


Figure 1

- (a) Arrange the tRNAs according to the codons on mRNA in 5' – 3' direction. [1]
 (b) Write the sequence of bases on DNA template strand for the above mRNA. [1]
- (vii) Observe **Figure 2** carefully and answer the questions that follow.

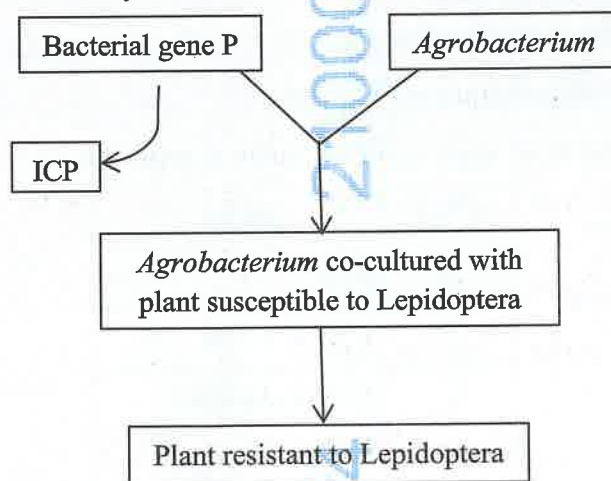


Figure 2

- (a) Name the source of gene 'P'. [1]
 (b) What helped the susceptible plant to develop into a resistant plant? [1]
- (viii) Answer the following questions.
- (a) Expand NHGRI. [1]
 (b) What are the radiolabelled oligonucleotides that bind to the target DNA during Southern blotting, also known as? [1]

- (ix) Given below are two statements marked Assertion and Reason. Read the two statements carefully and choose the correct option. [1]

Assertion: Site Directed Mutagenesis is used to introduce specific changes in DNA sequences.

Reason: In Site Directed Mutagenesis, the desired change in DNA sequence is introduced by deleting a nucleotide from the sequence.

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion.
- (b) Both Assertion and Reason are true but Reason is not the correct explanation for Assertion.
- (c) Assertion is true and Reason is false.
- (d) Both Assertion and Reason are false.
- (x) Given below are two statements marked Assertion and Reason. Read the two statements carefully and choose the correct option. [1]

Assertion: One of the major objectives of proteomics is to determine the 3-D structure of proteins.

Reason: 3-D structure of proteins can be obtained by gel electrophoresis.

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion.
- (b) Both Assertion and Reason are true but Reason is not the correct explanation for Assertion.
- (c) Assertion is true and Reason is false.
- (d) Both Assertion and Reason are false.

SECTION B - 28 MARKS

Question 2

[2]

- (i) Refer to the mRNA segment shown below in *Figure 3*, which can encode an oligopeptide of *five* amino acids.



Figure 3

- (a) Mention the bases present in 'X' and 'Y' codons.
- (b) In general, codons show non-ambiguity. How is 'X' an exception to it?

- (ii) During an experiment Shabana selected a sample with eight DNA fragments. She collected DNA from the sample and chose to run many cycles of polymerisation to achieve amplification. [2]
- (a) Identify the technique Shabana adopted.
- (b) Find the total number of DNA fragments after she ran six cycles of polymerisation.

Question 3

Answer the following questions

- (i) (a) Tryptophan operon consists of a regulator, a promoter, an operator and five structural genes. [2]
- What roles do regulator gene and promoter gene play if the tryptophan concentration increases in an *E.coli*?
- (b) In animal cell culture, monolayer cultures can be scaled up by using Roller Bottle. Discuss this process of scale up. [2]

OR

- (ii) (a) *Non genetic* RNAs play an important role in protein synthesis. [2]
- What role do *ribosomal* RNA and *small nuclear* RNA play in protein metabolism?
- (b) Plants with seedless fruits can be obtained by using conventional methods as well as *tissue culture technology*. [2]
- Describe the tissue culture method to obtain such plants.

Question 4

State *any two* differences between each of the following:

- (i) *Agrobacterium mediated gene transfer* and *Liposome mediated gene transfer* [2]
- (ii) *Chemostat* and *Turbidostat* (Based on photometer and flow rate of medium) [2]

Question 5

- (i) Before the development of recombinant human insulin, diabetic patients were treated by the insulin obtained from animal sources. It caused many side effects. Recombinant human insulin was developed by a pharmaceutical company, which was safer and more cost effective.
- (a) Explain how recombinant human insulin was developed by the pharmaceutical company using *E.coli* as a host cell. [3]
- (b) Why is eukaryotic host considered a better option than prokaryotic host for developing recombinant human insulin? [1]

OR

- (ii) In 1991, Superbug was used as a bioremediation tool after Exxon Valdez oil spill in Alaska, USA.
- (a) What is *bioremediation*? [1]
- (b) How was Superbug developed? [3]

Question 6

- (i) Bacteriophage Lambda has a double stranded linear DNA genome of 48502 bp. [2]
It has its two ends known as COS sites.
What are COS sites? How is the desired gene incorporated in bacteriophage Lambda?
- (ii) **Figure 4** below shows a 3-D structure of a biomolecule which plays an important role in central dogma. Study it carefully and answer the questions that follow. [2]

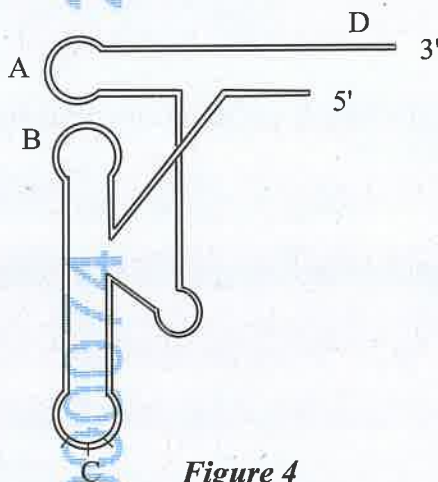


Figure 4

- (a) Mention the importance of the part labelled 'C'.
- (b) What role does the part labelled 'D' play in central dogma?

Question 7**[4]**

Identify the enzymes based on their usage in following processes:

- (i) Formation of DNA from mRNA
- (ii) Removal of RNA during the formation of cDNA library
- (iii) Cleaving the DNA fragment within the recognition sites without the use of energy
- (iv) Tenderisation of meat

Question 8**[4]**

Venkatesh was asked by his professor to isolate pure DNA from *Lactobacillus* and find the position of the genes coding for β -galactosidase and permease enzymes. He was provided with all the required equipment and chemicals to carry out the process.

Illustrate the steps that Venkatesh would follow to isolate pure DNA from *Lactobacillus*.

SECTION C – 28 MARKS**Question 9**

- (i) What is *DNA sequencing*? Describe the method of DNA sequencing that involves chain termination using radiolabelled ddNTPs. **[4]**
- (ii) What is *genomics*? Briefly explain the types of genomics. **[3]**

OR

- (iii) In a tragic aeroplane crash, all passengers lost their life. The aviation department approached the forensics to identify the bodies from the carcass before handing them over to their respective relatives. **[4]**

Elaborate the method used by forensics to identify the passengers.

- (iv) Define *bioinformatics*. Highlight the contributions of NCBI and DDBJ in the field of bioinformatics. **[3]**

Question 10

- (i) Proteins are polymers of amino acids which are found freely in the cytosol. Before their polymerisation, amino acids need to be activated and transported to the site of protein synthesis. [4]

Explain how the amino acids are activated and transported in correct sequence to form a protein.

- (ii) Discuss *any three* properties of a plasmid vector developed by the University of California. [3]

Question 11

- (i) **Figure 5** shows a device used for gene transfer in the host cells. [4]

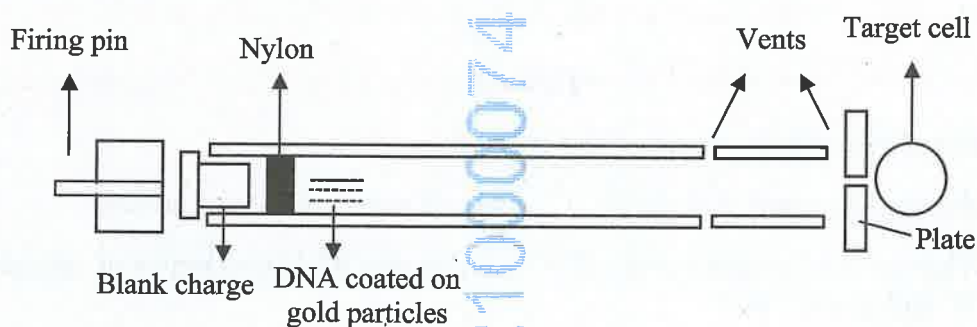


Figure 5

- (a) Identify the device shown in **Figure 5**.
(b) Mention the function of a blank charge in this device.
(c) Why are the vents necessary in this device?
(d) The process of gene transfer fails if brass is used instead of gold in this device. Explain.

- (ii) Observe **Figure 6** carefully and answer the questions that follow.

[3]

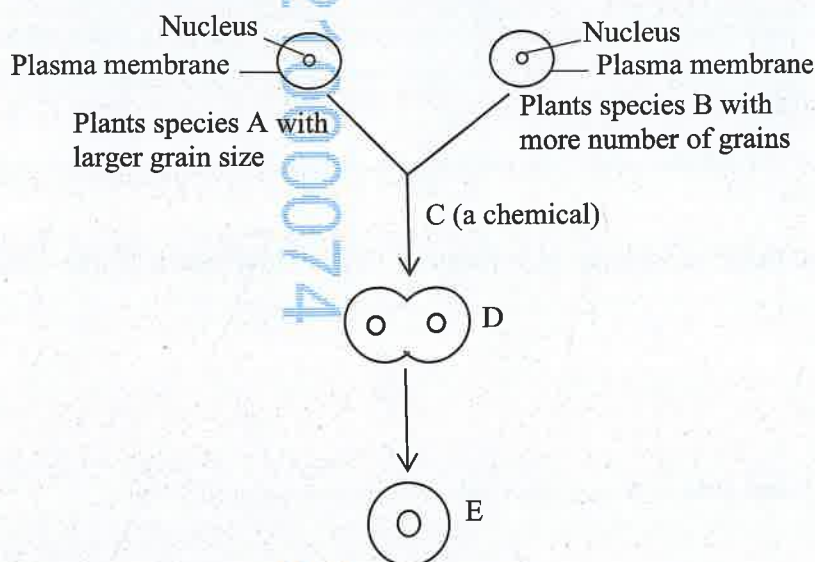


Figure 6

- Identify the process depicted in **Figure 6**.
- Mention the name of chemical 'C'. State its role in the above process.
- What are the expected traits of 'E' with respect to the properties of species 'A' and species 'B'?

Question 12

Three young researchers Aisha, Neil and Farah were screening their bacterial cultures for recombinant bacteria.

- Aisha used a plasmid that carried a gene for a protein responsible for fluorescence, obtained from a jelly fish, alongside the target gene.
- Neil used *Lac Z* gene to insert the desired gene. He found that some colonies were white while others were blue.
- Farah used a plasmid with amp^R and tet^R . She introduced the desired gene in tet^R gene. She first plated the bacteria on ampicillin medium before replica-plating onto tetracycline medium.

- How would Aisha detect the fluorescent protein in the recombinant hosts? [1]
- Explain the molecular basis behind the difference in colour as observed by Neil. [3]

- (iii) Why did Farah first plate the bacteria on ampicillin medium?
- (iv) How were the methods used by Farah and Neil interrelated?

[2]

[1]

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