

BIOTECHNOLOGY
PAPER 1
(THEORY)

W7001146

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 **8 printed pages**.
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 [].

Instruction to Supervising Examiner

1. Kindly read **aloud** the Instructions given above to all the candidates present in the examination hall.

SECTION A – 14 MARKS

Question 1

- (i) During the process of gel electrophoresis, migration of DNA fragments can be visualised by using certain dyes. Which is the most commonly used dye during this process? [1]

- (ii) A strain of bacteria that has a doubling-time of 10 minutes was cultured using L.B. agar medium. The culture was incubated for an hour. [1]

If 1400 bacterial cells were inoculated on the medium, how many bacterial cells are expected to be present in the bacterial colony after an hour?

- (iii) A desired DNA is inserted within the coding sequence of an enzyme, β -galactosidase that is a part of *Lac operon* in *E. coli* bacterium. X-gal is used to identify the recombinant colonies. [1]

Which one of the following is **INCORRECT** with reference to the above information?

- (a) Insertional inactivation of gene.
(b) Insertional inactivation of *Lac Z*.
(c) Recombinant colonies produce blue colour.
(d) Recombinant colonies produce no colour.
- (iv) During DNA profiling, the following fragments of DNA were subjected to gel electrophoresis. [1]

S.No.	Fragments	Number of bases (kb)
1.	A	25
2.	B	48
3.	C	28
4.	D	51

Write the order of sequence in which these fragments will migrate from the cathode towards the anode.

- (v) Give a reason for each of the following: [1]
- (a) Colchicine is used during synchronisation of cells in plant cell culture. [1]
(b) Sparged tank bioreactors are preferred to stirred tank bioreactors. [1]

- (vi) Observe the following DNA sequence that is acted upon by an enzyme to form overhangs.

5' – ACGATCAGCATCGATCTG – 3'

3' – TGCTAGTCGTAGCTAGAC – 5'

- (a) Identify and write the DNA sequence the enzyme will act upon. [1]
(b) What are such enzymes known as? [1]

(vii) Observe **Figure 1** and answer the questions that follow.

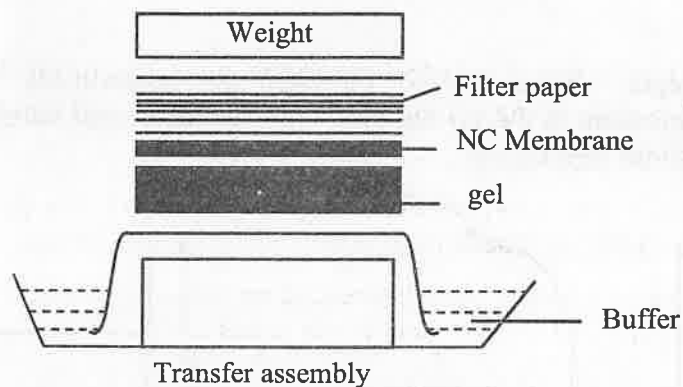


Figure 1

(a) Identify the technique represented in **Figure 1**. [1]

(b) What type of hybridisation takes place in this technique? [1]

(viii) Answer the following questions:

(a) Expand ICGEB. [1]

(b) What is the short DNA sequence that occurs only once in a genome and used as a landmark for physical mapping of a genome, known as? [1]

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

Assertion: Some animal cells divide *in-vitro* till they fill the surface of the culture vessel and then stop dividing.

Reason: Such cells can be grown only up to limited generations.

(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 statements carefully and choose the correct option. [1]

Assertion: Turbidostat operates best at high dilution rate.

Reason: Dilution rate in turbidostat is constant.

(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.

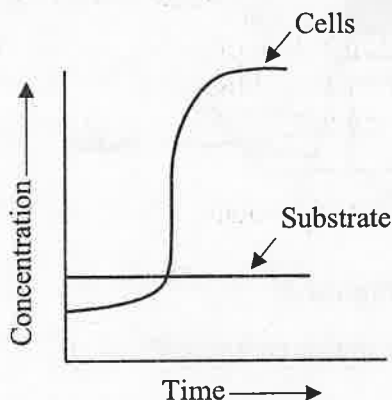
(c) Assertion is true and Reason is false.

(d) Both Assertion and Reason are false.

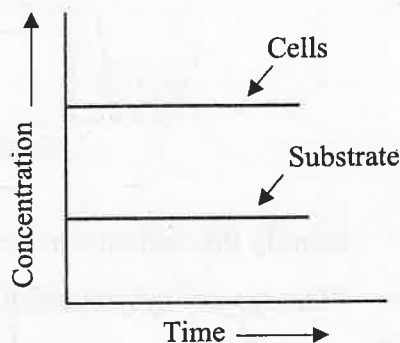
SECTION B – 28 MARKS

Question 2

- (i) The graphs shown below represent an experiment used to study gene expression in *E. coli* bacteria. Observe the graphs carefully and answer the questions that follow. [2]



Graph 1



Graph 2

- (a) Identify the cultures represented in **Graph 1** and **Graph 2**.
- (b) Why is the culture represented in **Graph 2** preferred to the culture depicted in **Graph 1** while synthesising antibiotics?
- (ii) A DNA molecule has an equal number of purine and pyrimidine bases. It has two antiparallel strands which form the double helical structure proposed by Watson and Crick. [2]
- (a) Mention the technique that was used by Watson and Crick to propose the double helical structure of DNA.
- (b) A fragment of DNA has a total of 980 base pairs. It has 360 guanine bases. Find out the number of purine bases present in this DNA fragment.

Question 3

- (i) Answer the following questions:
- (a) Myoglobin is made up of 153 amino acids in a single polypeptide chain. Certain enzymes play an important role in the synthesis of such kind of proteins. How do these enzymes initiate the process of synthesis of myoglobin? [2]
- (b) Maintenance of aseptic conditions is an important step in cell culture technology. Discuss how culture room and nutrient media are maintained at these conditions. [2]

OR

(ii) Answer the following questions:

- (a) A microbiologist is studying the regulation of gene expression in *E. coli* bacterium and observes that certain genes in the operon are expressed only in the presence of lactose. [2]

How is gene expression regulated in the presence of lactose in this bacterium?

- (b) Gautami is a senior researcher and leads the team of junior researchers who have been assigned the task of making biodegradable plastic bottles. The team has to create biodegradable plastic bottles to help reduce the garbage waste. [2]

Suggest the process that can be followed by Gautami and her team to produce such bottles.

Question 4

[4]

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

- (i) Genomic DNA library and cDNA library
(ii) Liposome mediated gene transfer and *Agrobacterium* mediated gene transfer.

Question 5

- (i) Nowadays, farmers are able to grow crops of enhanced nutritional value and longer shelf life. It has been possible due to the application of genetic engineering in agriculture.

- (a) Explain how Calgene, a California based company, used the application referred to above and developed tomatoes that have a longer shelf-life. [2]
(b) Discuss how Prof. Ingo Potrykus and Peter Beyer contributed to the development of a specific rice variety with high nutritional value. [2]

OR

- (ii) Biotechnology has helped in engineering various enzymes by using site directed mutagenesis technique. Such enzymes are now used in different industries and are also eco-friendly and harmless.

- (a) Mention the name and source of an enzyme that breaks the peptide bond and dissolves the protein to remove stains from fabrics. [2]
(b) Mention the name and source of a proteolytic enzyme that is highly effective as a softening agent and enhances the taste of canned foods. [2]

Question 6

Answer the following questions.

- (i) Recircularisation is a limitation in rDNA technology and can be overcome by using a specific enzyme. Mention the name of the enzyme and explain how it helps to overcome this limitation. [2]
- (ii) Observe the following diagram of a vector commonly used in rDNA technology and answer the questions that follow. [2]

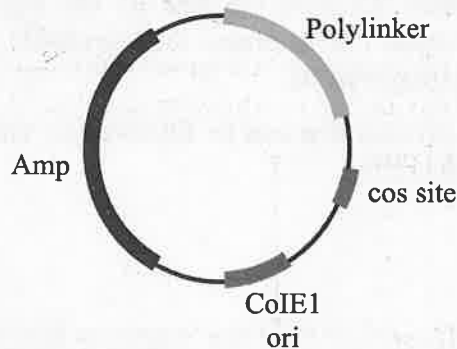


Figure 2

- (a) Identify the vector and the source of its *cos* site.
- (b) How are such vectors introduced into suitable host cells?

Question 7

[4]

Identify the instruments based on their usages stated below.

- (i) It maintains CO₂ concentration for growth of cells.
- (ii) It measures the microvolumes of a liquid.
- (iii) It sterilises the enzymes and vitamins.
- (iv) It helps in the study and analysis of large and heavy samples by providing larger working distance.

Question 8

[4]

Vinitha and Shekhar study microbiology and have to develop culture media for Fungi and *Lactobacillus* bacteria respectively. They are provided with some artificially synthesised chemicals and some natural compounds.

Discuss the type of media that would be developed by Vinitha for Fungal culture and Shekhar for *Lactobacillus* culture. State the specific components of the culture media to be developed by them.

SECTION C – 28 MARKS

Question 9

- (i) What are *cell lines*? Describe the process of growth of adherent cell lines and suspension cell lines in their specific culture medium. Which of these cell lines grows faster? [4]
- (ii) Mention *any three* criteria while selecting an organism for genome sequencing. [3]

OR

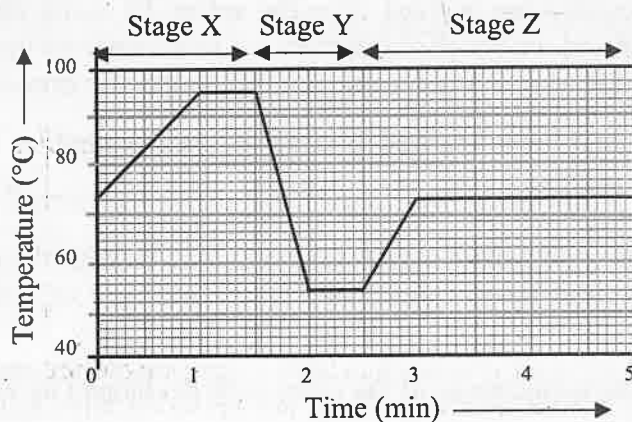
- (iii) What is an *explant*? Describe various types of differentiation that an explant undergoes during its development while being cultured. [4]
- (iv) Mention *three* types of proteomics. [3]

Question 10

- (i) The technique of DNA profiling is used to resolve parental disputes and solve criminal cases. This technique uses comparison of unique sequences of genes between two or more individuals. [4]
- Who developed this technique? Briefly discuss such types of sequences.
- (ii) Explain *transcriptional unit*. [3]

Question 11

- (i) The graph shown below depicts the changes in temperature during one cycle of DNA amplification technique. Study the graph carefully and answer the questions that follow. [4]



- (a) What does Stage X represent?
- (b) Why is the temperature lowered in Stage Y?
- (c) Mention the name and source of the enzyme involved in this technique.
- (d) If the total number of cycles of DNA amplification is 12 in 2 hours, what would be the number of copies of DNA at the end of the process?

- (ii) **Figure 3** represents the response of an explant to certain nutrients present in the culture medium at different stages. Study the diagram and answer the questions that follow. [3]

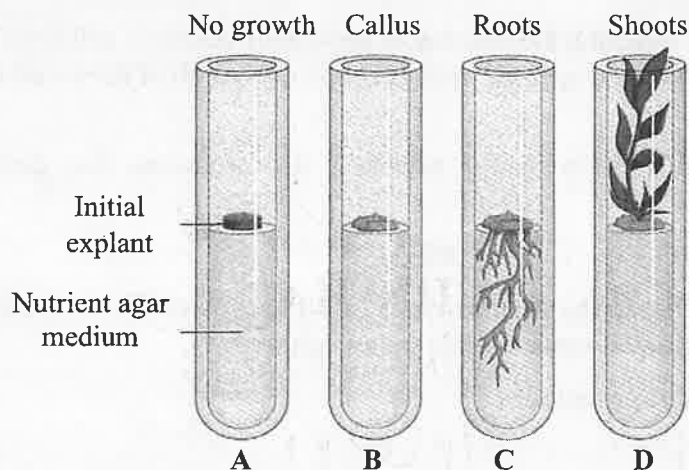


Figure 3

- What is the cause of changes that occur in test tube 'C'?
- How does the explant respond to the nutrients present in test tube 'D'?
- What led the explant to change into the stage depicted in test tube 'B'?

Question 12

George Kohler and Cesar Milstein were awarded Nobel Prize for their contribution to the field of medicine. While performing an experiment on inventing a specific technique, they injected a specific antigen in a mouse. The dose of injection was repeated several times. After the final dose, the spleen of the mouse was removed and specific lymphocytes were isolated from the spleen by using density gradient centrifugation. They fused the lymphocytes with cells that undergo uncontrolled cell division. The fused cells were then cultured to produce specific proteins.

- Which technique is being referred to in the above passage? [1]
- Which type of lymphocytes were used in the above technique? [1]
- How did Kohler and Milstein fuse the lymphocytes with the other types of cells? What are the fused cells known as? What type of proteins do they produce? [3]
- Mention *any two* applications of the fused cells developed by using the above technique. [2]