

BIOTECHNOLOGY
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 [].

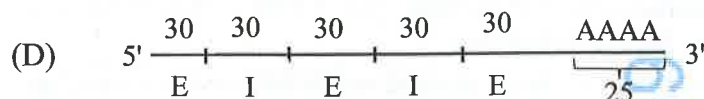
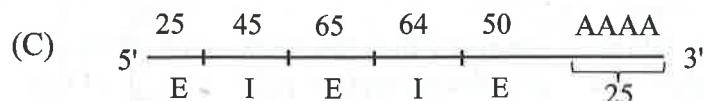
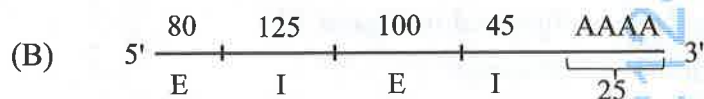
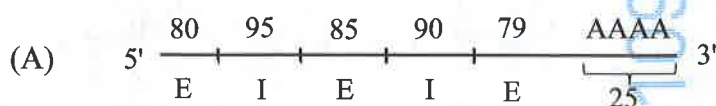
Instruction to Supervising Examiner

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 the process of DNA isolation from bacterial cell, a lysis buffer containing EDTA and other enzymes is used. Why is EDTA added in the lysis buffer? [1]
- (ii) Dr. Preeti extracted a DNA fragment of 6.8 nm for amplification. If this fragment contains 20% adenine, how many hydrogen bonds are present in it? [1]
- (iii) Cell lines derived from primary cell culture can be of different types. Which one of the following is **NOT** a property of finite cell lines? [1]
- Limited number of cell divisions
 - Decline in growth rate after some time
 - Consistently high yield of cells
 - Anchorage dependence
- (iv) The number of bases in exons (E) and introns (I) of four primary transcripts obtained in yeast cells is given below. [1]



Arrange these primary transcripts in the ascending order based on the number of bases present on functional mRNA.

- (v) Give a reason for each of the following:
- A co-repressor is required along with a repressor in a repressible operon to stop the process. [1]
 - ESTs* are obtained from mRNA and not genomic DNA. [1]

- (vi) Observe the alignment of two nucleotide sequences given below and answer the questions that follow.

A	T	C	G	A	A	C	T	G	G	C	C	—	—
T	A	G	C	C	A	C	T	G	A	G	G	A	A

- (a) Identify the type of sequence alignment. [1]
 (b) Write the name of bioinformatic tool which is preferred to find the type of alignment shown above. [1]
- (vii) Observe **Figure 1** and answer the questions that follow.

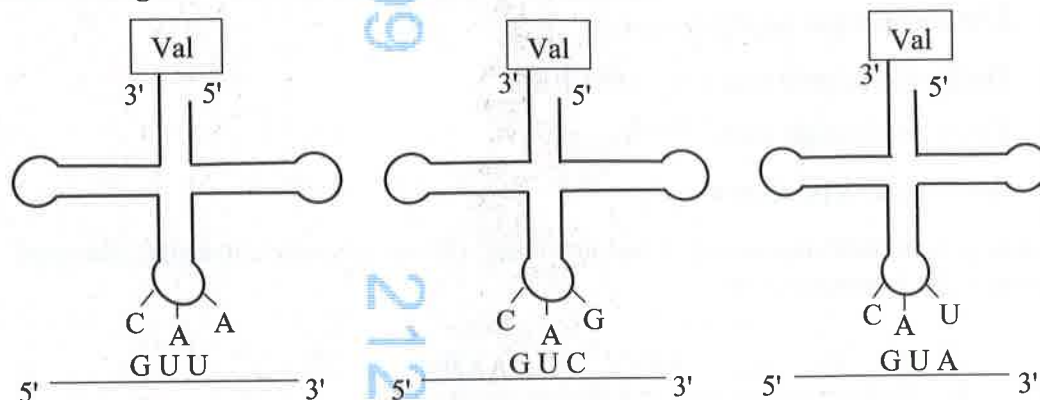


Figure 1

- (a) Which property of genetic code is illustrated in **Figure 1**? [1]
 (b) Why do genetic codes exhibit such property? [1]
- (viii) Answer the following questions. [1]
 (a) Expand EMBL. [1]
 (b) In a study on Proteome, Bhushan observes that the same gene produces different proteins in different cell types. Which type of proteomics does this refer to? [1]
- (ix) Given below are two statements marked Assertion and Reason. Read the two statements carefully and choose the correct option. [1]
Assertion: Sodium alginate is used to encapsulate somatic embryos to develop *synthetic seeds*.
Reason: Sodium alginate is used as a solidifying agent.
- (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: *Tissue Engineering* provides various implants such as blood vessels, heart valves, ligaments etc.

Reason: *Tissue Engineering* is based on hybridoma technology that helps in providing such implants.

- (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) Observe **Figure 2** carefully and answer the questions that follow.

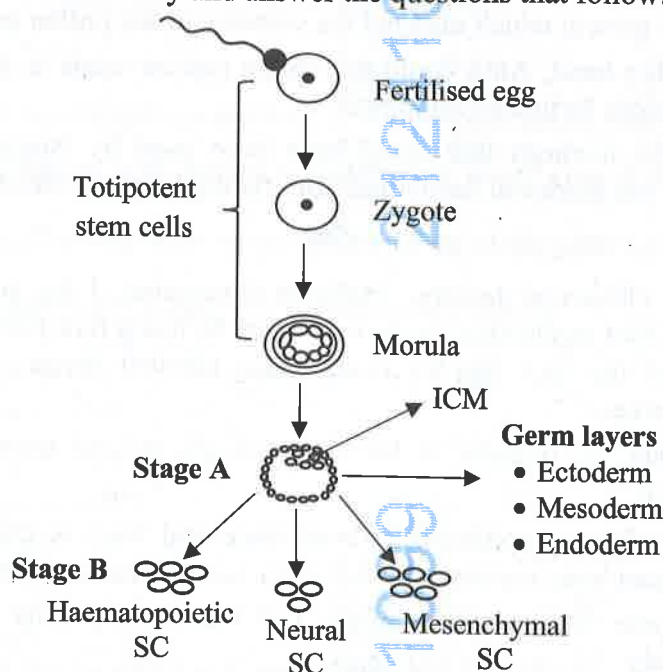


Figure 2

- (a) What levels of stem cells do Stages 'A' and 'B' represent?
(b) Why is Stage B preferred to Stage 'A' in stem cell therapy?

- (ii) During replication of DNA of 10^5 bp, one strand is replicated continuously while the other is replicated discontinuously, forming *leading* and *lagging* strands respectively. This process is supported by various enzymes and *RNA primers*. [2]
- (a) Which enzyme plays an important role in removing the RNA primers from the replicated DNA of prokaryotic cells?
- (b) Find out the number of discontinuous fragments formed on the lagging strand if the size of each discontinuous fragment is 200 bp in length.

Question 3

Answer the following questions.

- (i) (a) *Interferons* are glycoproteins that are produced by virus infected mammalian cells. A specific recombinant interferon is produced by inserting cDNA in a suitable host cell by using a suitable vector. [2]
- What type of host cells are used to produce recombinant interferons? Give a reason.
- (b) Anjana and Amit were working on crop improvement programme using plant tissue culture. Anjana found that the pollen tube did not reach the ovule due to its slow growth which affected the viability of the pollen grains. [2]
- On the other hand, Amit could not obtain mature seeds as the embryos got aborted before further development.
- Suggest the methods that could have been used by Anjana and Amit to overcome the aforesaid limitations. Briefly explain each method.

OR

- (ii) (a) During a classroom lecture, Taufique demonstrated the semiconservative mode of DNA replication in chromosomes by using root tips of *Allium cepa*. He treated the root tips by using radio labelled thymidine to label the chromosomes. [2]
- What would he observe in the first and the second generation of DNA replication?
- (b) Tisha is culturing epithelial cells of mice and Ravi is culturing the cells derived from bone marrow of mice using suitable culture mediums. [2]
- Mention *any two* properties of the cell lines obtained by Tisha and Ravi respectively.

Question 4

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

- (i) *Western Blotting* and *Northern Blotting* [2]
- (ii) *Cryopreservation* and *Trypsinisation* [2]

Question 5

- (i) *Recombinant DNA technology* is widely used to obtain novel crops, medicines, vaccines, hormones etc. It requires various enzymes, vectors and suitable host cells. YAC is a commonly used vector in this technology.

- (a) Mention *any two* important features of YAC as a vector. [2]
(b) How is a recombinant DNA produced? [2]

OR

- (ii) Recombinant Hepatitis B vaccines can be produced from genetically engineered eukaryotic cells. These vaccines are safer than the conventional vaccines.

Now a days, transgenic plants such as tomato and potato are also used to obtain such vaccines that can be taken orally and the use of syringe can be avoided in administering the vaccine to children.

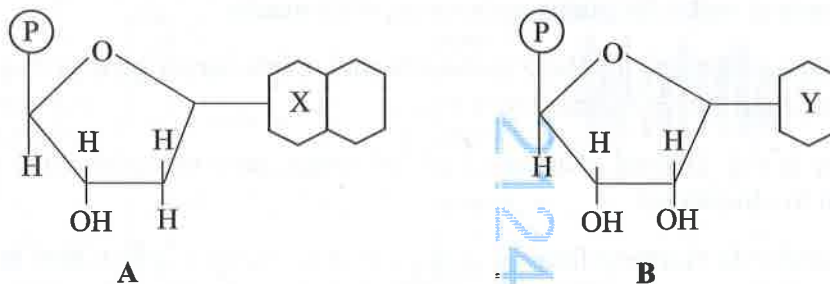
- (a) Explain how eukaryotic cells are genetically engineered to produce recombinant Hepatitis B vaccine. [2]
(b) Mention the names and application of *any two* vaccines obtained from transgenic plants. [2]

Question 6

- (i) In yeast, the desired genes cannot be stored in the form of *genomic DNA library*. [2]

- (a) Which type of gene library is preferred in yeast? Give a reason.
(b) Mention the role of *S1 nuclease* in making of the gene library in yeast.

- (ii) Observe **Figure 3** and answer the questions that follow. [2]



- (a) Identify the biomolecules represented by 'A' and 'B'.
(b) Which one is more stable? Give a reason.

Question 7**[4]**

With reference to *cell culture technology*, identify the technique / device / chemicals used to:

- (i) preserve viable seeds using liquid nitrogen.
- (ii) isolate specific cells from heterogeneous cell population by using fluorescent dyes.
- (iii) monitor the viability of cells based on colour.
- (iv) culture adherent cell lines by increasing surface area.

Question 8**[4]**

Two young Biotechnologists, Kunal and Shazia were working in a biotechnology lab to improve the thermal stability of subtilisin, a protease enzyme widely used in detergent industry.

After analysing the structure of enzyme, they decided to make a change at a key position in the gene coding for subtilisin by replacing aspartate residue (encoded by GAU) with valine residue (encoded by GUU). They carried out the required change following the method developed by a Nobel Laureate using M13 bacteriophage.

Explain the technique used by Kunal and Shazia.

SECTION C – 28 MARKS**Question 9**

- (i) *Agrobacterium tumefaciens* is known as a natural genetic engineer. It carries a plasmid that causes *crown gall* tumour in dicots. This plasmid is used to transfer desired genes to make the plants resistant to viral attacks.

- (a) Illustrate the steps involved in the insertion of the target gene in this plasmid to produce the desired trait in the plant. **[3]**

- (b) Why is this method of insertion of the target gene more effective in dicots than in monocots? **[1]**

- (ii) During a research, Hardeep found a new gene in a mouse. Explain how he can use each of the following bioinformatics tools to analyse the function and biological role of this gene: **[3]**

- (a) ENTREZ
- (b) Taxonomy Browser
- (c) GENSCAN

OR

- (iii) Vikas has completed Masters in Biotechnology. He wants to develop genetically identical exotic orchids which cannot be cultivated using conventional and vegetative propagation methods. He used the apical shoots of these orchids to obtain their clones.
- (a) Illustrate the steps involved in the process that Vikas needs to follow to develop the clones of the exotic orchids. [3]
- (b) How can *in-vitro* rooting be induced in this process? [1]
- (iv) What is *DNA microarray*? State its principle. [3]

Question 10

- (i) Gel electrophoresis is used as a low-resolution technique to separate biomolecules like nucleic acids and proteins. It is also performed in other biotechnology processes.
- (a) Mention *any two* other biotechnology processes in which Gel electrophoresis is performed. [2]
- (b) Explain the method by which the molecules are separated by using this technique. [2]
- (ii) Mention *any three* components of a stirred tank bioreactor. State the use of each of these components. [3]

Question 11

- (i) **Figure 4** shows an important technique in biotechnology. Observe the figure carefully and answer the questions that follow.

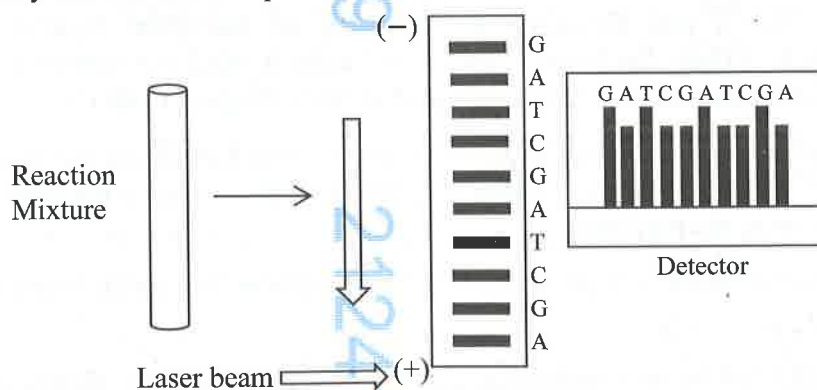


Figure 4

- (a) Identify the technique depicted in **Figure 4**.
- (b) Mention the main component of the reaction mixture that is responsible for determination of the DNA sequence by the detector.
- (c) Why is laser beam used in the technique depicted above?
- (d) How does ddNTP differ from dNTP?

(ii) Observe **Figure 5** given below and answer the questions that follow.

[3]

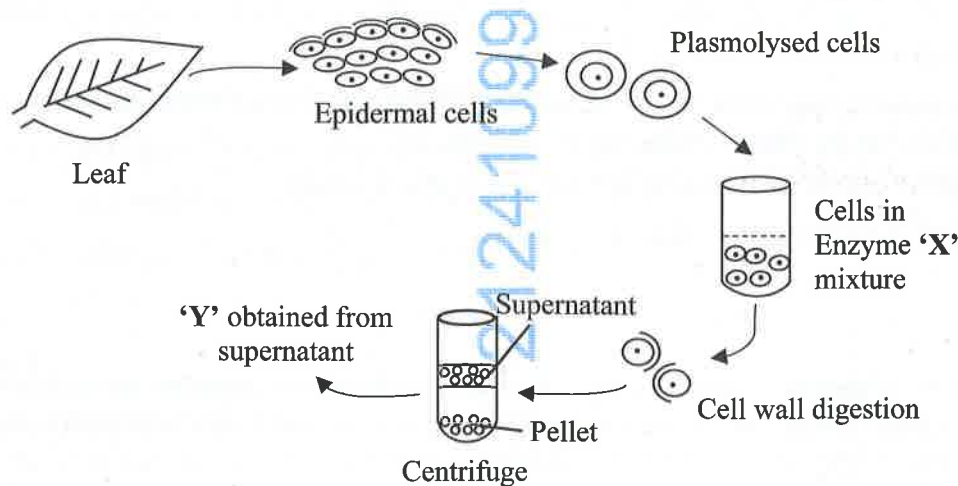


Figure 5

- Mention the names of *any two* enzymes that are present in enzyme mixture labelled 'X'.
- Identify the part labelled 'Y' that can be cultured in suitable nutrient medium.
- When cultured, 'Y' varies greatly in shape and size. Explain how colchicine can bring it to the same phase of cell cycle.

Question 12

Two microbiologists, Meera and Benjamin are working on microbial cultures in biotechnology laboratory. They keep the volume of culture medium constant by continuously adding fresh medium and removing equal volume of spent medium.

Meera is working on antibiotic production using *Streptomyces* which produces antibiotics like erythromycin and kanamycin. She regulates the growth of *Streptomyces* by limiting the glucose concentration in the medium.

Benjamin is growing *E.coli* for biofuel production. His bioreactor is fitted with sensors to monitor cell density.

- Identify the types of open continuous culture systems used by Meera and Benjamin. [1]
- Which phase of growth kinetics is maintained by both Meera and Benjamin in their respective culture systems? Why is this phase important for large scale production? [2]

- (iii) Compare the culture systems used by Meera and Benjamin on the following bases: [3]
- (a) Dilution rate
 - (b) Flow rate of the medium
 - (c) Optical density
- (iv) Draw a graph showing the substrate concentration and cell growth with respect to time. [1]