BIOTECHNOLOGY
PAPER 1
(THEORY)

Maximum Marks: 70
Time Allotted: Three Hours
Reading Time: Additional Fifteen minutes

Instructions to Candidates

- You are allowed **an additional 15 minutes** for **only** reading the question paper.
- You must **NOT** start writing during reading time.
- This question paper has **8** printed pages.
- There are **three** sections in the paper: **A, B** and **C**. **Internal choices** have been provided in **two questions** in **Section B** and in **one question** in **Section C**.
- Answer ***all*** questions.
- **Section A** consists of ***one question*** each carrying ***one mark*.**
- While answering **Multiple Choice Questions** in Section A, you are required to write **ONLY** one option as the correct answer.
- **Section B** consists of ***eight questions*** each carrying ***four marks***.
- **Section C** consists of ***four questions*** each carrying ***seven marks***.
- The intended marks for questions are given in brackets [ ].

Instruction to Supervising Examiner

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

Source: CISCE (cisce.org) • Specimen Question Paper with Marking Scheme

SECTION A – 14 MARKS

Question 1

(i) While performing the process of Western Blotting technique, the scientists use specific proteins. What type of proteins do the scientists use during this process? **(Recall)** **[1]**

(ii) A forensic scientist discovered a tiny spot of blood at a crime scene. The sample underwent 10 PCR cycles for 40 minutes. Calculate how many copies of DNA would be present at the end. **(Application)** **[1]**

(iii) Which nitrogenous base will **NOT** be present in the genetic material of a eukaryotic cell? **(Recall)** **[1]**

(a) Cytosine

(b) Guanine

(c) Thymine

(d) Uracil

(iv) The following proteins of given molecular weight are subjected to Gel electrophoresis. **[1]**

S. No.	Proteins	Mol. Wt.
1.	Albumin	23,000
2.	Keratin	48,000
3.	Myosin	1,25,000
4.	Haemoglobin	84,000
5.	Ribozyme	62,000
6.	Insulin	1,14,000

Write the order of Sequence in which these proteins are isolated in a gel. **(Analysis)**

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

(a) A good vector used in rDNA technology must have atleast one selectable marker. **[1]**

(b) Continuous culture is preferred over batch culture. **[1]**

(vi) Base sequence in one of the strands of DNA is 5' - TAG CAT GAT – 3'.

(a) Write the base sequences of its complementary strand. **(Analysis)** **[1]**

(b) Explain the base complementarity rule. **(Recall)** **[1]**

(vii) Observe the following figure carefully and answer the questions that follow:

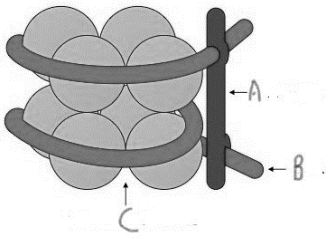


Figure 1

Source: CISCE (cisce.org) • Specimen Question Paper with Marking Scheme

(a) Identify ***Figure 1***. Where is this structure found? **(Recall)** **[1]**

(b) What is its importance with respect to a prokaryotic and a eukaryotic organism? **(Understanding)** **[1]**

(viii) Answer the following questions.

(a) Expand EMBL. **(Recall)** **[1]**

(b) What is the variation in length of DNA fragments due to inherited differences in highly repetitive DNA, known as? **(Understanding)** **[1]**

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

Assertion: *Trp operon* is an inducible operon.

Reason: Tryptophan inhibits the process of formation of Lactose in *Trp operon*. **(Understanding)**

(a) Both Assertion and Reason are true and Reason is 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: In *gel electrophoresis*, molecules get separated according to their charge to mass ratio.

Reason: The more the charge on the molecule, more is its mass. **(Analysis)**

(a) Both Assertion and Reason are true and Reason is 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.

Source: CISCE (cisce.org) • Specimen Question Paper with Marking Scheme

SECTION B – 28 MARKS

Question 2

(i) *Figure 2* represents an experiment conducted in the laboratory. Observe the following figure carefully and answer the questions that follow: **[2]**

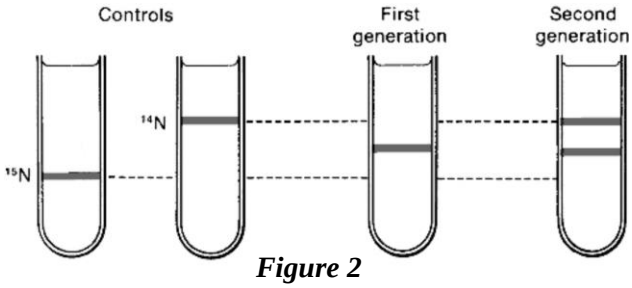


Figure 2

(a) What was the objective of the experiment depicted in ***Figure 2***?

(Understanding)

(b) How was the DNA separated into different layers? **(Analysis)**

(ii) A selectable marker is used in the selection of recombinants on the basis of their ability to produce colour in the presence of a chromogenic substrate. **[2]**

(a) Mention the name of the mechanism involved. Which enzyme is responsible for the production of colour? **(Understanding)**

(b) How is it advantageous to use chromogenic substrate method over using antibiotic resistant gene, to select the recombinants? **(Analysis)**

Question 3 **[4]**

(i) Answer the following questions:

(a) In general, DNA carries a gene for a particular protein. To produce this protein, DNA synthesises RNA and RNA synthesises protein. Sometimes, few viruses contain only RNA but no DNA, still they synthesise protein. Elaborate the process of formation of DNA in such viruses. **(Understanding)**

(b) During plant cell culture, certain growth regulators are required for proper plant culture. Describe the role of such growth regulators.

(Understanding)

OR

(ii) Answer the following questions:

(a) The wavelength that are absorbed by the nucleic acid and the efficiency of its absorption during its estimation, depends both on the structure and concentration of the molecules. Elaborate ***any one*** method of nucleic acid estimation based on absorption of light.

(Understanding)

(b) Radhika wishes to find out the sequence of the DNA of a strawberry plant. Suggest the steps she should follow to isolate the DNA from the strawberry plant. **(Understanding)**

Source: CISCE (cisce.org) • Specimen Question Paper with Marking Scheme

Question 4 **[4]**

State *any two* significant differences between the following: **(Understanding)**

(i) Purine bases and Pyrimidine bases

(ii) Leading strand and Lagging strand

Question 5 **[4]**

(i) A study by few scientists, reports a decrease in non-target insect populations in areas where Bt crops are extensively cultivated.

(a) Explain the mode of action of the Bt toxin that provides resistance to the plants against insect infestations. **(Understanding)**

(b) What is the source of Bt toxin? **(Understanding)**

OR

(ii) *Eli* Lily is one of the first pharmaceutical companies to produce human insulin using rDNA technology by cell based fermentation method.

(Understanding and Application)

(a) Explain how *Eli Lily* synthesised the human insulin.

(b) How was insulin obtained before the advent of rDNA technology?

Question 6 **[4]**

Answer the following questions:

(i) A gene was being ligated to the plasmid vector to prepare a recombinant DNA. An *exonuclease* was added to the tube accidentally. How will it affect the next step of the experiment? **(Analysis)**

(ii) Observe the following DNA sequence carefully.

5´- A T C G A A T T C T A C -3´

3´- T A G C T T A A G A T G -5´ **(Understanding)**

(a) Identify the specific sequence that is acted upon by a particular endonuclease enzyme.

(b) What term is used for the sequence that is acted upon by the endonuclease? What is the name of the endonuclease enzyme that acts on the above sequence?

Source: CISCE (cisce.org) • Specimen Question Paper with Marking Scheme

Question 7 **[4]**

Falak is starting a new experiment involving the germination of seeds for subsequent tissue culture. Outline a step-by-step protocol for sterilizing the following:

(Understanding)

(i) Instruments

(ii) Culture medium

(iii) Explants

(iv) Vitamins

Question 8 **[4]**

Richard, a young marine biotechnologist, is designing an oil-eating bacteria for bioremediation using genetic engineering. He has chosen a particular bacterial strain and introduced specific genes to enhance its oil-digesting capabilities. Enumerate the steps Richard took while designing the recombinant bacteria for bioremediation.

(Analysis)

SECTION C – 28 MARKS

Question 9

(i) What is a *monolayer culture*? Describe how feeding and nutrient distribution are managed in large-scale monolayer cultures using roller bottles. **[4]**

(Understanding)

(ii) Mention *any three* types of alignments developed by BLAST. **(Recall)** **[3]**

OR

(iii) What is the purpose of synchronizing cells in a suspension culture? Discuss *any three* chemical methods commonly used for synchronizing suspension cultures. **[4]**

(Understanding)

(iv) Mention *any three* major database sources. **(Recall)** **[3]**

Question 10

(i) Restriction enzymes are also called molecular scissors. They cut the DNA at specific sites. They are of different types. Discuss different types of restriction enzymes used in rDNA technology. Who discovered these enzymes? **[4]**

(Understanding and Recall)

(ii) Explain the 3 – D structure of DNA. **(Understanding)** **[3]**

Source: CISCE (cisce.org) • Specimen Question Paper with Marking Scheme

Question 11

(i) ***Figure 3*** shows an important event that occurs during normal cellular metabolism. Study the figure given below and answer the questions that follow: **[4]**

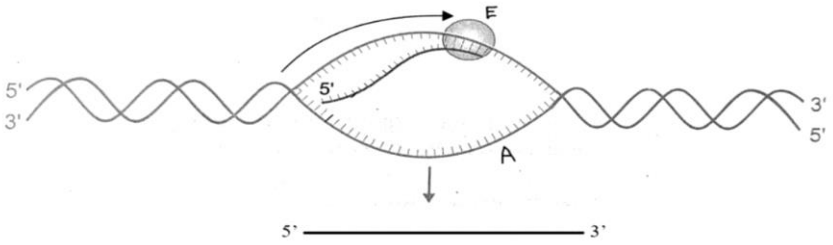


Figure 3

(a) Which process is being depicted in ***Figure 3***? **(Understanding)**

(b) Explain the role of part labelled 'E'. **(Understanding)**

(c) Which factor helps the part 'E' to initiate the process shown above? What is importance of strand A? **(Understanding)**

(d) If the sequence of strand A is 5' – A T G C A C T A G C T A C G – 3', then what should be the sequence on the newly formed strand? **(Analysis)**

(ii) ***Figure 4*** shows an important process used in forensics. Study the figure given below and answer the questions that follow. **[3]**

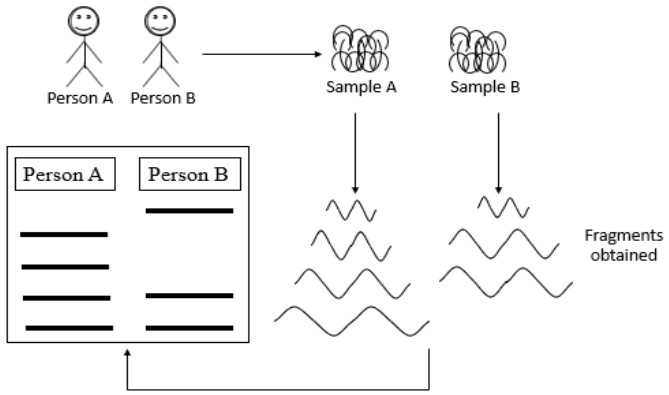


Figure 4

(a) Which material is collected from Person A and Person B to start the process depicted in ***Figure 4***?
Briefly discuss the role of this material in the body of an individual? **(Understanding)**

(b) Explain the method of obtaining the fragments collected from sample A and sample B. **(Understanding)**

(c) Describe the process of obtaining the bands from sample A and sample B? **(Understanding)**

Source: CISCE (cisce.org) • Specimen Question Paper with Marking Scheme

Question 12

Khalid, David and Anuradha were working on yeast genome. They performed a process to digest the yeast genome and plasmid vector containing Lac Z gene with *Eco*RI restriction enzyme. The genomic fragment that we obtained was mixed with the cut vectors using DNA ligase. The yeast genome was inserted within the Lac Z gene of the plasmid *E. coli* cells were transformed with the ligation mix containing the rDNA and plated on solid agar medium containing X-Gal. They observed that some plasmid vectors self –ligated and did not carry the yeast genome.

(i) Name the enzyme that was used to ligate the yeast genome with the plasmid. **[1]**
(Recall)

(ii) Describe the technique they can use to distinguish the non-recombinant vector from the recombinant ones. **[1]**
(Understanding)

(iii) Why is this method of selection referred to insertional inactivation of antibiotic resistance gene? **[3]**
(Understanding)

(iv) How could they have prevented self-ligation of the plasmid? **(Application)** **[2]**

COUNCIL FOR THE INDIAN SCHOOL CERTIFICATE EXAMINATIONS
CISCE
NEW DELHI

Source: CISCE (cisce.org) • Specimen Question Paper with Marking Scheme

BIOTECHNOLOGY
PAPER 1
(THEORY)

ANSWER KEY

SECTION A – 14 MARKS

Question 1

In answering Multiple Choice Questions, candidates have to write either the correct option number or the explanation against it. Please note that only ONE correct answer should be written.

(i) Antibodies / Immunoglobulins **[1]**

(ii) 1024 **[1]**

(iii) (d) or Uracil **[1]**

(iv) The sequence of proteins obtained from top (cathode) to bottom (anode) in a gel:-
Myosin > Insulin >Haemoglobin> Ribozyme > Keratin > Albumin. **[1]**

(v) (a) To select the host cell with recombinant DNA **[1]**

(b) To obtain maximum production **[1]**

(vi) (a) 3 ' – ATC GTA CTA – 5' **[1]**

(b) Chargaff's equivalence rule **[1]**

(vii) (a) Nucleosome, found in eukaryotic chromosomes **[1]**

(b) found in eukaryotic chromosomes for supercoiling of DNA, absent in prokaryotic organisms. **[1]**

(viii) (a) European Molecular Biology Laboratory **[1]**

(b) VNTR – Variable number of tandem repeats **[1]**

(ix) (d) Both Assertion and Reason are false. **[1]**

(x) (c) or Assertion is true but Reason is false. **[1]**

Source: CISCE (cisce.org) • Specimen Question Paper with Marking Scheme

SECTION B – 28 MARKS

Question 2

(i) **[2]**

(a) To prove that replication of DNA is semiconservative

(b) Density Gradient Centrifugation using cesium chloride (CsCl)

(ii) **[2]**

(a) Insertional Inactivation. β-Galactosidase

(b) Selection of recombinants due to inactivation of antibiotics requires simultaneous plating on two plates having different antibiotics.

Question 3 **[4]**

(i) (a) Process of reverse transcription to be explained briefly.

(b) Growth regulators are the specific hormones such as Auxins and cytokinins and their role in plant cell culture.

OR

(ii) (a) Elaborating either spectrophotometry or colorimetry based on Beer – Lambert's Law

(b) Isolation of DNA from Plant cell using macerases, cellulose, pectinase etc. followed by use of SDS, ethanol….

Question 4 **[4]**

(i) Purine bases have double rings – pyrimidine bases have single ring

(ii) Leading strand polymerizes continuously, lagging strand polymerizes in fragments.

Question 5 **[4]**

(i) (a) Bt toxin is insecticidal crystal protein or δ-endotoxin against insects

(b) Bacillus thuringiensis

OR

(ii) (a) Process of development of humulin using gene for chain A and chain B separately in the *E.coli* bacterium.

(b) It was obtained from the calf (bovine insulin) or the pig (porcine insulin)

Source: CISCE (cisce.org) • Specimen Question Paper with Marking Scheme

Question 6 **[4]**

(i) There will no effect on the experiment. This is because a recombinant DNA is circular and closed with no free ends. Therefore, the exonuclease will not degrade the DNA.

(ii) (a) 5 − G↓AATTC – 3
3− CTTAA↑G – 5

(b) Palindromic sequence. *Eco*RI

Question 7 **[4]**

(i) Dry heat sterilization in hot air oven

(ii) Wet heat sterilization in Autoclave

(iii) Surface sterilization or chemical sterilization using NaOCl or $HgCl_2$

(iv) Membrane filtration

Question 8 **[4]**

Bacteria is *Pseudomonas putida*. Different strains have individual plasmids with genes for enzymes to digest octane, naphthalene, camphor and xylene (the components of petroleum). These genes were introduced in one single strain which could digest all the components.

SECTION C – 28 MARKS

Question 9

(i) When the bottom of the culture vessel is covered with a continuous layer of cells in one cell thickness, they are called monolayer cultures. The monolayer culture is anchorage dependent subculture, therefore, it needs scale – up process by increasing the surface area of the substrate in proportion to the number of cells and volume of the medium. A round bottle or tube is rolled around its axis by rollers as the medium along with the cells runs around, inside the bottle. The cells are adhesive, therefore, they attach to the inner surface of the bottle and grow forming a monolayer. **[4]**

(ii) Any Three of these types of alignments are Local alignment, global alignment, pair wise alignment, multiple sequence alignment. **[3]**

OR

(iii) A synchronous culture is regarded as a culture in which cell cycles or specific phase of cycles for majority of cultured cells occurs simultaneously so that the cell culture grows properly. **[4]**

It is achieved by starvation, mitotic arrest and inhibition

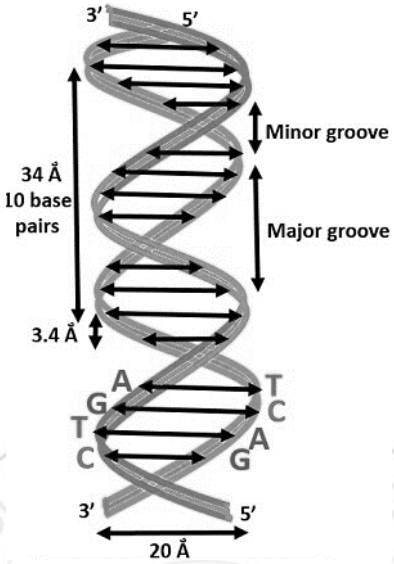
(iv) Major Database sources are NCBI, EMBL, DDBJ, SWISS-PROT, EMBL, GenBank, GENSCAN *(any three)*. **[3]**

Source: CISCE (cisce.org) • Specimen Question Paper with Marking Scheme

Question 10

(i) Type I, Type II and Type III to be discussed. Arber discovered these enzymes. **[4]**

(ii) Diagram of DNA **[3]**



Question 11

(i) (a) Transcription **[4]**

(b) E is the enzyme called RNA polymerase involved in transcription.

(c) Sigma factor. Strand labelled A is coding strand.

(d) 5' – A U G C A C U A G C U A C G – 3'.

(ii) (a) DNA, genetic material in the human body **[3]**

(b) Using Restriction enzymes

(c) Gel electrophoresis

Question 12

(i) DNA ligase **[1]**

(ii) Blue white method of screening the recombinants **[1]**

(iii) As it can help in identification based on colour – visual detection, highly sensitive **[3]**

(iv) By using Alkaline phosphatase enzyme **[2]**

Source: CISCE (cisce.org) • Specimen Question Paper with Marking Scheme