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Biotechnology: Principles and Processes — CBSE Class 12 Biology Chapter Test

FREE CHAPTER TEST · CLASS XII · BIOLOGY (044) · PATTERN OF THE CBSE SAMPLE QUESTION PAPER 2026-27

TIME ALLOWED	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
1½ hours	37	17 (A 8 · B 3 · C 3 · D 1 · E 2)	

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 17 questions. All questions are compulsory.
2. This question paper is divided into five sections: A, B, C, D and E.
3. Section A (Q1–8) contains 6 multiple choice questions and 2 assertion-reason based questions of 1 mark each.
4. Section B (Q9–11) contains short answer questions of 2 marks each.
5. Section C (Q12–14) contains short answer questions of 3 marks each.
6. Section D (Q15) contains case-based questions of 4 marks each, with sub-parts of 1, 2 and 1 marks.
7. Section E (Q16–17) contains long answer questions of 5 marks each.
8. There is no overall choice. However, an internal choice has been provided in 2 questions in Section B, 1 question in Section D, 2 questions in Section E. Attempt only one of the alternatives in such questions.
9. Draw neat, labelled diagrams wherever necessary.
10. This chapter test follows the section structure, question types and marks per question of the CBSE Class XII Biology (044) Sample Question Paper 2026-27, at about half the length of the 70-mark board paper: 37 marks in 1½ hours.
11. The answer key and the marking scheme are at the end of this booklet. Attempt the paper in 1½ hours before you look at them.

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Chapter: Biotechnology: Principles and Processes · **Topics:** Principles of biotechnology · Restriction enzymes and gel electrophoresis · Cloning vectors and competent hosts · Isolation, cutting and amplification of DNA (PCR) · Insertion of recombinant DNA and selection · Bioreactors and downstream processing

SECTION A

This section comprises 8 questions of 1 mark each: 6 multiple choice questions (MCQs) and 2 assertion-reason based questions.

1. Which of the following sequences (written 5′ → 3′ on one strand of double-stranded DNA) is a palindrome? 1

(A) 5′-GAATTC-3′ (B) 5′-GAATCC-3′

(C) 5′-GATTAC-3′ (D) 5′-GGATTC-3′

2. Starting from one DNA molecule, the number of copies after 10 cycles of PCR (assuming perfect doubling) is 1

(A) 20 (B) 100

(C) 512 (D) 1024

3. The bacterium used as a natural genetic engineer to deliver genes into plant cells is 1

(A) Escherichia coli (B) Agrobacterium tumefaciens

(C) Bacillus thuringiensis (D) Salmonella typhimurium

4. The enzyme lysozyme is used to break open the cell walls of 1

(A) plant cells (B) fungal cells

(C) bacterial cells (D) animal cells

5. The first recombinant DNA was made by linking a gene for antibiotic resistance with a native plasmid of 1

(A) Escherichia coli (B) Agrobacterium tumefaciens

(C) Thermus aquaticus (D) Salmonella typhimurium

6. The two core techniques that enabled the birth of modern biotechnology are 1

(A) genetic engineering, and the maintenance of sterile conditions in chemical engineering processes (B) tissue culture and hybridisation

(C) fermentation and distillation (D) PCR and DNA fingerprinting

7. **Assertion (A):** Exonucleases remove nucleotides from the ends of a DNA molecule. 1
Reason (R): Endonucleases cut DNA only at its ends.

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is not the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

8. **Assertion (A):** A cloning vector must contain an origin of replication (ori). 1
Reason (R): Restriction enzymes belong to the class of nucleases called endonucleases.

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is not the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

SECTION B

This section comprises 3 short answer questions of 2 marks each.

9. (a) Explain how the restriction enzyme EcoRI gets its name. 2

OR

(b) What are 'sticky ends'? Why are they useful in genetic engineering?

10. (a) Why does a cloning vector need (i) an origin of replication and (ii) a selectable marker? 2

OR

(b) What is a cloning site? Why should a vector have only one recognition site for the restriction enzyme used?

11. A linear DNA molecule has the sequence (one strand) 5′-ATGCGAATTCTTAGCCATGGTACGAATTCGGATCCAA-3′. How many fragments are obtained when it is cut completely with EcoRI (site GAATTC)? How many would be obtained if the same two EcoRI sites were present in a circular plasmid? 2

SECTION C

This section comprises 3 short answer questions of 3 marks each.

12. Describe the three steps of each cycle of the polymerase chain reaction (PCR). 3

13. Describe how DNA fragments are separated and recovered by agarose gel electrophoresis. 3

14. How can recombinant colonies be distinguished from non-recombinant ones using (i) antibiotic resistance genes and (ii) the gene for β-galactosidase? 3

SECTION D

This section comprises 1 case-based question of 4 marks, with sub-parts of 1, 2 and 1 marks.

15. A student isolates DNA from three sources in the laboratory: bacterial cells, plant leaves and a fungus. She breaks open the cells with suitable enzymes, treats the extract with RNase and protease, and finally adds chilled ethanol. Fine threads of DNA appear, which she collects on a glass rod.

(I) Which enzyme should she use to break the cell walls of the plant cells? [1]

(II) Why are RNase and protease added? What happens when chilled ethanol is added? [2]

(III) Which enzyme breaks the cell walls of fungal cells? [1]

OR

(III) What is meant by 'spooling'? [1]

SECTION E

This section comprises 2 long answer questions of 5 marks each.

16. (a) List and describe the steps involved in recombinant DNA technology. 5

OR

(b) Explain how restriction endonucleases and DNA ligase are used to make recombinant DNA. What is a palindromic nucleotide sequence?

17. (a) Describe the methods used to introduce recombinant DNA into host cells. 5

OR

(b) What is a bioreactor? Describe a stirred-tank bioreactor and the conditions it maintains. What is downstream processing?

END OF THE QUESTION PAPER

ANSWER KEY — SECTION A

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
(A)	(D)	(B)	(C)	(D)	(A)	(C)	(B)

MARKING SCHEME AND WORKED SOLUTIONS

Marks for each step are shown in brackets, as in the CBSE marking scheme. Any correct alternative method earns full marks.

Q1. Answer (A). GAATTC reads the same 5′ → 3′ on both strands (its complementary strand, read 5′ → 3′, is also GAATTC).

Q2. Answer (D). Each cycle doubles the DNA: $2^{10} = 1024$.

Q3. Answer (B). Agrobacterium tumefaciens transfers a piece of its Ti plasmid DNA (T-DNA) into dicot plant cells.

Q4. Answer (C). Lysozyme acts on bacterial cell walls; plant cell walls need cellulase and fungal cell walls chitinase, while animal cells have no cell wall.

Q5. Answer (D). Stanley Cohen and Herbert Boyer (1972) cut out a piece of DNA with an antibiotic-resistance gene and linked it with a plasmid of Salmonella typhimurium.

Q6. Answer (A). Genetic engineering changes the genetic material; sterile (contamination-free) processes allow only the desired microbe or cell to grow in large quantities.

Q7. Answer (C). A is true. R is false: endonucleases make cuts at specific positions within the DNA. Answer C.

Q8. Answer (B). Both are true: the ori lets the linked DNA replicate in the host and controls the copy number; the class of restriction enzymes is unrelated to this. Answer B.

Q9. (2 marks) Answer: (a) Escherichia coli, strain RY13, first enzyme; (b) overhangs that pair with complementary ends.
(a) E: the genus Escherichia; co: the species coli. [1] R: the strain (RY 13) from which it was isolated; I: the order in which it was isolated from that strain (the first). [1]
OR (b) Many restriction enzymes cut the two strands a little away from the centre of the palindrome, between the same two bases on each strand, leaving single-stranded overhanging stretches at the ends. [1] These 'sticky ends' form hydrogen bonds with complementary cut ends; so DNA from different sources cut with the same enzyme can be joined end to end by DNA ligase. [1]

Q10. (2 marks) Answer: (a) replication and copy number; identifying transformants; (b) single recognition site.
(a) (i) Replication starts at the ori; any piece of DNA linked to it can replicate in the host cell, and the ori also controls the copy number of the linked DNA. [1] (ii) A selectable marker (e.g. a gene for resistance to ampicillin, tetracycline or kanamycin) helps to identify and select the transformants and to eliminate the non-transformants. [1]
OR (b) A cloning site is a recognition site for a restriction enzyme in the vector, where the foreign DNA is ligated. [1] There should be only one such site for the enzyme chosen, since several sites would cut the vector into many pieces and complicate cloning. [1]

Q11. (2 marks) Answer: 3; 2.
The sequence has two EcoRI sites (GAATTC occurs twice), so the linear DNA is cut into three fragments. [1]
A circular molecule with two sites is cut into two fragments. [1]

Q12. (3 marks) Answer: denaturation, annealing (primers), extension (Taq).
Denaturation: the double-stranded DNA is heated to a high temperature so that the two strands separate. [1]
Annealing: two sets of short chemically synthesised primers bind to the complementary regions at the ends of the target DNA on the single strands. [1]
Extension: a thermostable DNA polymerase (Taq polymerase) extends the primers using the nucleotides provided, copying the target region; repeating the cycle many times amplifies the DNA to about a billion copies. [1]

Q13. (3 marks) Answer: move to anode, separate by size, ethidium bromide, elution.
The DNA fragments are loaded in an agarose gel (a natural polymer from sea weeds) and an electric field is applied; being negatively charged, they move towards the anode. [1]
The gel acts as a sieve: the fragments separate according to their size, smaller ones moving farther. [1]
The separated DNA is stained with ethidium bromide and seen as bright orange bands in UV light; the bands are cut out of the gel and the DNA is extracted from the gel piece (elution) for use in constructing recombinant DNA. [1]

Q14. (3 marks) Answer: loss of tetracycline resistance; blue-white selection.
(i) Insertional inactivation of an antibiotic resistance gene: e.g. in pBR322, DNA inserted in the tet^R gene; recombinants grow on ampicillin but not on tetracycline, while non-recombinants grow on both. [1] This needs replica plating on two media, which is cumbersome. [½]
(ii) The foreign DNA is inserted within the coding sequence of β-galactosidase, which is then inactivated. [½] On a medium with a chromogenic substrate, non-recombinant colonies give a blue colour, while recombinant colonies give no colour (white). [1]

Q15. (4 marks) Answer: (I) cellulase; (II) remove RNA and protein; DNA precipitates; (III) chitinase, or winding DNA threads.
(I) Cellulase. [1]
(II) RNA and proteins (such as histones) associated with DNA are removed by treatment with ribonuclease and protease respectively. [1] Purified DNA precipitates out on addition of chilled ethanol, as fine threads in the suspension. [1]
(III) Chitinase. [1]
OR (III) Collecting the precipitated threads of DNA by winding them around a glass rod. [1]

Q16. (5 marks) Answer: (a) isolate, cut, amplify, ligate, transform, express; (b) palindromes, sticky ends, ligase.
(a) Isolation of DNA: cells are broken open (lysozyme, cellulase, chitinase); RNA and proteins are removed (RNase, protease); DNA is precipitated with chilled ethanol. [1] Cutting at specific locations: purified DNA and the vector are cut with the same restriction enzyme, and the fragments are checked and separated by gel electrophoresis. [1] Amplifying the gene of interest using PCR. [1] Ligation: the gene of interest is joined to the cut vector by DNA ligase, forming recombinant DNA, which is inserted into competent host cells (transformation) and the transformants selected. [1] Obtaining the foreign gene product: the host cells are grown on a large scale, often in bioreactors, so that the gene is expressed and the recombinant protein is produced and then purified (downstream processing). [1]
OR (b) Restriction endonucleases recognise a specific palindromic sequence of base pairs (e.g. GAATTC for EcoRI) and cut each strand of the DNA at specific points within it. [1½] Palindromes read the same on the two strands when the orientation of reading is kept the same ($5' \to 3'$). [½] EcoRI cuts between G and A on both strands, leaving single-stranded AATT overhangs (sticky ends). [1] When the vector and the source DNA are cut with the same enzyme, the sticky ends are complementary, and DNA ligase joins them, forming recombinant DNA. [1½] The making of recombinant DNA was first done by Stanley Cohen and Herbert Boyer in 1972. [½]

Q17. (5 marks) Answer: (a) Ca^{2+} + heat shock, microinjection, gene gun, disarmed pathogens; (b) stirred-tank bioreactor; separation, purification, quality control.

(a) Competent bacteria: DNA, being hydrophilic, cannot pass through cell membranes, so bacterial cells are treated with a divalent cation such as calcium, which increases the efficiency with which DNA enters through pores in the cell wall. [1] The cells are incubated with recombinant DNA on ice, given a brief heat shock (42 °C) and placed back on ice, so that they take up the DNA. [1] Microinjection: recombinant DNA is injected directly into the nucleus of an animal cell. [1] Biolistics (gene gun): plant cells are bombarded with high-velocity micro-particles of gold or tungsten coated with DNA. [1] Disarmed pathogen vectors: e.g. Agrobacterium, whose Ti plasmid has been modified so that it no longer causes tumours, or disarmed retroviruses, deliver the gene into plant or animal cells. [1]

OR (b) Bioreactors are large vessels (100–1000 litres) in which raw materials are converted into specific products using microbial, plant, animal or human cells; they provide optimal conditions — temperature, pH, substrate, salts, vitamins and oxygen. [1½] The commonly used stirred-tank bioreactor is cylindrical (or has a curved base) for mixing; it has a stirrer, an oxygen delivery system, a foam control system, temperature and pH control systems, and sampling ports. [1½] Downstream processing: after the biosynthetic stage, the product is separated and purified, and formulated with suitable preservatives; for drugs, strict quality control testing and clinical trials are needed. [2]

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