



INDIAN SCHOOL AL WADI AL KABIR



Class: XII	Department: SCIENCE 2026 – 2027 SUBJECT: BIOLOGY	Date: 13/10/2026
Worksheet:09 with answers	UNIT- IX- BIOTECHNOLOGY CHAPTER: 09 BIOTECHNOLOGY: PRINCIPLES AND PROCESSES	Note: A4 FILE FORMAT
CLASS & SEC:	NAME OF THE STUDENT:	ROLL NO.

I. MULTIPLE CHOICE QUESTIONS (1M)

- Which two core techniques gave birth to modern biotechnology?
 - Plant tissue culture and animal husbandry
 - Genetic engineering and bioprocess engineering
 - Gel electrophoresis and PCR amplification
 - Restriction digestion and DNA spooling
- While isolating DNA from a filamentous fungus cell, which enzyme is specifically used to dissolve the cell wall?
 - Lysozyme
 - Cellulase
 - Chitinase
 - Protease
- In cloning vector pBR322, the presence of antibiotic resistance genes (amp^R) and (tet^R) primarily helps to:
 - Identify and select the transformants from non-transformants
 - Initiate the replication of the foreign DNA fragment
 - Keep the host cell alive at extremely high temperatures
 - Cut the plasmid vector at unique palindromic sites
- What is the correct sequence of the three cyclic steps in a Polymerase Chain Reaction (PCR)?
 - Extension → Annealing → Denaturation
 - Denaturation → Extension → Annealing
 - Annealing → Denaturation → Extension
 - Denaturation → Annealing → Extension
- Which step belongs strictly to downstream processing rather than the biosynthetic stage?
 - Bubbling sterile air through a sparged bioreactor
 - Separation and purification of the expressed protein
 - Inducing competence in host cells using calcium ions
 - Adding Taq polymerase and primers to a reaction mix

Two statements are given - one labelled as **Assertion (A)** and the other labelled as **Reason (R)**. Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

- A. Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of the Assertion (A).
- B. Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- C. Assertion (A) is true, but Reason (R) is false.
- D. Assertion (A) is false, but Reason (R) is true.

6. **Assertion(A):** DNA cannot pass through a cell membrane without specialized treatment.

Reason(R): DNA is a hydrophilic molecule and cannot move across the hydrophobic lipid bilayer of cell membranes.

7. **Assertion(A):** *Taq* polymerase enzyme is used to amplify DNA during the extension step of a PCR cycle.

Reason(R): This enzyme remains stable and active even at the extremely high temperatures used for denaturation.

8. **Assertion(A):** Separation and purification are the core stages grouped under downstream processing.

Reason(R): These steps occur immediately after the biosynthetic phase inside a bioreactor is finished.

II. VERY SHORT ANSWER TYPE QUESTIONS(2M)

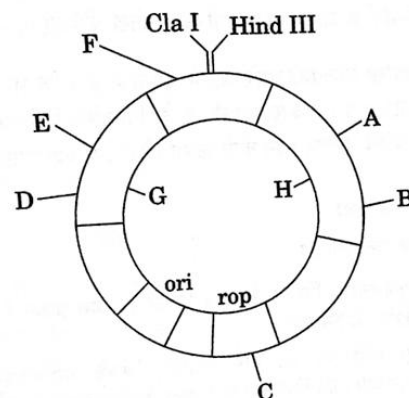
9. What is a palindromic nucleotide sequence? Give the specific palindromic sequence recognized by the restriction enzyme *EcoRI*.
10. Explain the term "Spooling" in the context of isolation of genetic material.
11. What are "sticky ends" in genetic engineering, and why are they important?
12. Why is the use of "Disarmed Pathogens" considered an effective vector system for transferring alien genes into plant and animal cells? Give examples.

III. SHORT ANSWER TYPE QUESTIONS (3M)

13. Make a chart (with diagrammatic representation) showing a restriction enzyme, the substrate DNA on which it acts, the site at which it cuts DNA, and the product it produces.
14. Can you recall meiosis and indicate at what stage a recombinant DNA is made?
15. Describe briefly the following:
 - (a) Origin of replication
 - (b) Bioreactors
 - (c) Downstream processing

IV. CASE STUDY BASED QUESTIONS (4M) (BOARD 2025-26)

16. We know that plasmids and bacteriophages are the most commonly used vectors in biotechnology experiments. If we can link an alien piece of DNA to the plasmid DNA, the alien DNA can be multiplied to equal the copy number of the plasmid. Engineered vectors are used these days. Study the diagram of the *E. coli* cloning vector pBR322 and answer the



questions that follow:

- A. Why are plasmids and bacteriophages used as cloning vectors?
- B. Identify:
 - (i) The gene in the cloning vector that controls the copy number of the vector.
 - (ii) The restriction site C in the 'rop' gene.
- C. Identify and name two desirable markers shown in the diagram.
- D. Name the two restriction sites each in the two genes you have identified as selectable markers.

V. LONG ANSWER TYPE QUESTIONS (5M)

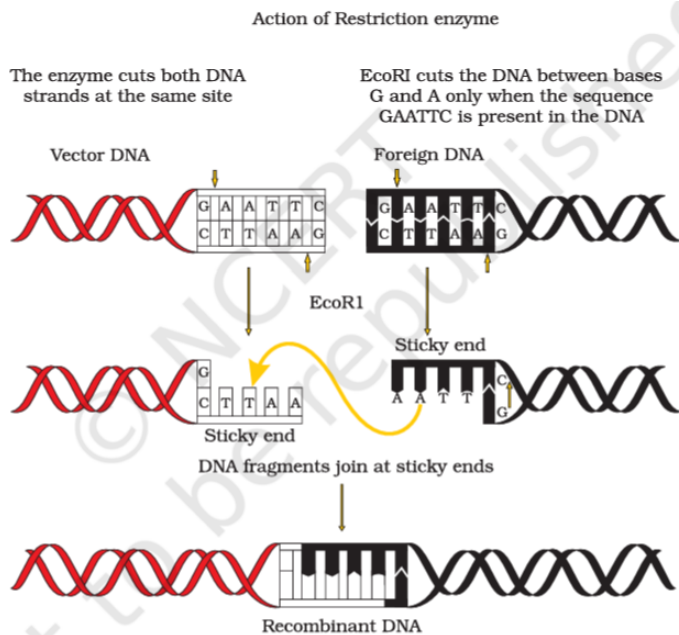
17. (i) Discuss with your teacher and find out how to distinguish between
 - (a) Plasmid DNA and Chromosomal DNA
 - (b) RNA and DNA
 - (c) Exonuclease and Endonuclease
- (ii) Collect 5 examples of palindromic DNA sequences by consulting your teacher. Better try to create a palindromic sequence by following base-pair rules.

VI. BOARD QUESTIONS

18. What is the role of the 'chilled ethanol' step during the final stage of DNA isolation? (CBSE 2024)
19. Name and sequence the three thermal cyclic stages of a single Polymerase Chain Reaction (PCR) process. Why can a regular human cell polymerase not be used in this automated method? (CBSE 2022)
20. Explain why an exonuclease enzyme cannot be utilized when you are trying to construct a functional recombinant DNA molecule. (CBSE 2023)

Answer Key

Q. No.	Answer
1	B. Genetic engineering and bioprocess engineering
2	C. Chitinase
3	A. Identify and select the transformants from non-transformants.
4	D. Denaturation → Annealing → Extension
5	B. Separation and purification of the expressed protein
	ASSERTION & REASONING
6.	A. Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of the Assertion (A).
7.	B. Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
8.	A. Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of the Assertion (A).
II	VERY SHORT ANSWER TYPE QUESTIONS(2M)
9.	A palindromic sequence is a sequence of base pairs that reads the same on the two strands when the orientation of reading is kept the same (e.g., 5' → 3'). $5' \rightarrow \text{GAATTC} \rightarrow 3'$ $3' \rightarrow \text{CTTAAG} \rightarrow 5'$
10.	Spooling is the mechanical process used to collect purified DNA threads. (1 Mark) It is achieved by adding chilled ethanol to the mixture, which causes the purified DNA to precipitate out as fine threads that can be wound out onto a glass rod.

11.	Sticky ends are overhanging, single-stranded DNA cuts left behind by restriction endonucleases. They are important because they form ready hydrogen bonds with their complementary cut pairs, making it much easier for DNA ligase to join the fragments together.
12.	Certain pathogens naturally possess highly efficient mechanisms to infect cells and transfer their own DNA into the host genome to manipulate cellular behavior. When these pathogens are "disarmed," their harmful, disease-causing genes are removed or replaced, but their highly effective DNA delivery machinery remains intact. For example, the <i>Agrobacterium tumefaciens</i> bacterium uses its modified Ti-plasmid to deliver useful genes into plant cells without causing tumors. Similarly, disarmed retroviruses are utilized in animal systems to safely deliver therapeutic genes into host cell lines.
III	SHORT ANSWER TYPE QUESTIONS (3M)
13.	The restriction enzyme EcoRI cuts DNA at a specific site:  The diagram illustrates the action of the restriction enzyme EcoRI. It shows a vector DNA (red) and a foreign DNA (black) both containing the GAATTC recognition sequence. EcoRI cuts both strands at the same site, between the G and A bases. This results in two fragments with sticky ends (overhanging AATTC sequences). The DNA fragments then join at their sticky ends to form recombinant DNA. - Enzyme: EcoRI - Substrate: DNA sequence - Site: Cuts between GAATTC - Product: Two fragments with sticky ends: one with an overhanging AATTC sequence.
14.	In meiosis, recombinant DNA is formed during Prophase I of meiosis, specifically in the pachytene stage. During this stage, crossing over occurs, where homologous chromosomes exchange genetic material. This process leads to the formation of new combinations of genes on the chromosomes, creating recombinant DNA. Here's how it happens: - Homologous chromosomes pair up, and segments of chromatids are exchanged between them. - The exchanged sections of the chromosome result in new combinations of alleles, which leads to genetic variation. - This recombination process is crucial for generating diversity in offspring.

15.	(a) Origin of replication: A DNA sequence where replication begins. It allows DNA to replicate within a host cell and can be linked to vectors to amplify specific DNA sequences. (b) Bioreactors: Large vessels used for growing organisms in controlled environments to produce biotechnological products. (c) Downstream processing: The process of isolating and purifying products after biosynthesis, followed by formulation and clinical trials.																					
IV	CASE STUDY BASED QUESTIONS (4M)																					
16.	A. Plasmids and bacteriophages have the unique ability to replicate inside bacterial cells independently of the control of chromosomal DNA. Because bacteriophages naturally have very high copy numbers per cell, their genomes are easily replicated alongside any integrated foreign DNA. B. (I) <i>ori</i> (Origin of Replication) sequence/gene. (II) <i>PvuII</i> restriction endonuclease site. C. The two selectable markers are: (<i>amp^R</i>) (Ampicillin resistance gene) (<i>tet^R</i>) (Tetracycline resistance gene) D. The restriction sites located inside each selectable marker gene are: - Inside the (<i>amp^R</i>) gene: <i>PstI</i> and <i>PvuI</i> - Inside the (<i>tet^R</i>) gene: <i>BamHI</i> and <i>SalI</i>																					
V	LONG ANSWER TYPE QUESTIONS (5M)																					
17.	(i) (a) <table><tr><th>Plasmid DNA</th><th>Chromosomal DNA</th></tr><tr><td>It is an extra-chromosomal DNA molecule, primarily found in bacteria.</td><td>It forms the complete genetic material in the cell, located in the chromosomes.</td></tr><tr><td>Plasmid DNA is capable of independent replication.</td><td>Chromosomal DNA replicates as part of cell division (mitosis or meiosis).</td></tr></table> (b) <table><tr><th>RNA</th><th>DNA</th></tr><tr><td>RNA is typically single-stranded.</td><td>DNA is double-stranded, forming a double helix structure.</td></tr><tr><td>RNA does not replicate by itself; it is synthesized from a DNA template.</td><td>DNA can replicate itself during cell division.</td></tr><tr><td>RNA contains ribose sugar, which has an extra oxygen atom.</td><td>DNA contains deoxyribose sugar, which lacks one oxygen atom.</td></tr></table> (c) <table><tr><th>Exonuclease</th><th>Endonuclease</th></tr><tr><td>Exonucleases are enzymes that remove nucleotides from the ends (5' or 3') of the DNA molecule.</td><td>Endonucleases are enzymes that cut the DNA molecule internally at specific recognition sites.</td></tr><tr><td>Exonucleases usually remove nucleotides one at a time from the ends of the DNA chain.</td><td>Endonucleases make cuts within the DNA strand to produce fragments with sticky or blunt ends.</td></tr></table> (ii) Palindromic sequences read the same backward and forward and are often recognized by restriction enzymes. Examples include: GAATTC		Plasmid DNA	Chromosomal DNA	It is an extra-chromosomal DNA molecule, primarily found in bacteria.	It forms the complete genetic material in the cell, located in the chromosomes.	Plasmid DNA is capable of independent replication.	Chromosomal DNA replicates as part of cell division (mitosis or meiosis).	RNA	DNA	RNA is typically single-stranded.	DNA is double-stranded, forming a double helix structure.	RNA does not replicate by itself; it is synthesized from a DNA template.	DNA can replicate itself during cell division.	RNA contains ribose sugar, which has an extra oxygen atom.	DNA contains deoxyribose sugar, which lacks one oxygen atom.	Exonuclease	Endonuclease	Exonucleases are enzymes that remove nucleotides from the ends (5' or 3') of the DNA molecule.	Endonucleases are enzymes that cut the DNA molecule internally at specific recognition sites.	Exonucleases usually remove nucleotides one at a time from the ends of the DNA chain.	Endonucleases make cuts within the DNA strand to produce fragments with sticky or blunt ends.
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	• AGCTT • AAGCTT • GGATCC • CCGG
VI	BOARD QUESTIONS
18.	Chilled ethanol precipitates the purified DNA from the cell solution, causing it to separate as visible, fine white threads that can be wound out via spooling.
19.	The three steps in a standard PCR cycle are: 1. Denaturation: Separating the two complementary strands of DNA using intense heat (~94°C). 2. Annealing: Lowering the temperature (~50–60°C) to allow oligonucleotide primers to hybridize/bind to the templates. 3. Extension: Thermostable polymerase extends the primers using free nucleotides (~72°C).
20.	Exonucleases remove nucleotides strictly from the outer terminal ends of a DNA molecule. They cannot perform internal cuts or produce the staggered, single-stranded "sticky ends" that are necessary for linking a foreign gene into a plasmid vector backbone.

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