

CLASS 12 BIOLOGY STUDY GUIDE

UNIT: BIOTECHNOLOGY

Chapters Covered:

- 1 *Biotechnology – Principles and Processes*
 - 2 *Biotechnology and its Applications*
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SECTION 1: THEORY IN SIMPLE WORDS (WITH VISUAL IMAGES & ANALOGIES)

CHAPTER 1 – BIOTECHNOLOGY: PRINCIPLES & PROCESSES

What is Biotechnology? (Simple Definition)

Biotechnology = Using living organisms (like bacteria, plants, DNA) to make useful products
→ medicines, vaccines, insulin, pest-resistant crops, etc.

Kid analogy:

Biotechnology is like using “tiny living machines” to build things humans need.

Core Principles of Biotechnology

1 Genetic Engineering

Changing the DNA of an organism.

 Think of DNA like a long recipe book. Genetic engineering = editing the recipe.

2 Bioprocess Engineering

Growing organisms (like bacteria) in large tanks to mass-produce products like insulin.

 Think of giant pressure cookers (bioreactors) making useful products.

Tools of Recombinant DNA Technology

1 Restriction Enzymes (Molecular Scissors

- Cut DNA at specific sites.
- Recognize palindromic sequences.

- Example: EcoRI cuts at GAATTC.

Visual Memory Trick:

"PAL-IN-DROME" = same forward & backward, like the word *NITIN*.

2 Vectors (DNA Delivery Vehicles 🚚)

Help transfer a gene from one organism to another.

Types of vectors:

- **Plasmids** (small circular DNA in bacteria)
- **Phages** (viruses that infect bacteria)
- **Cosmids, BACs, YACs** – large capacity vectors

Good vector must have:

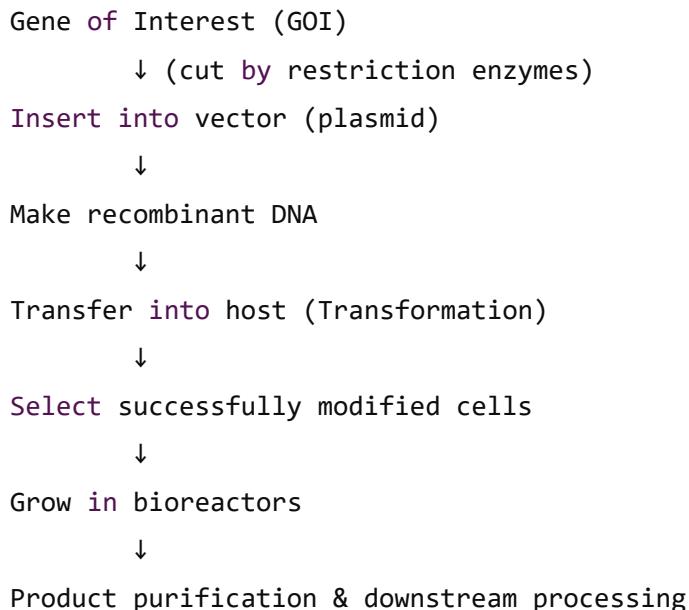
- **ORI** → place where replication starts
- **Selectable marker** → antibiotic resistance gene
- **Cloning site** → where foreign DNA is inserted

3 Host Organism (Factory Worker 👨‍🏭)

Usually *E. coli*, fungi, plants.

Steps of Recombinant DNA Technology (SUPER IMPORTANT)

Flowchart (Easy Visual)



Mnemonic:

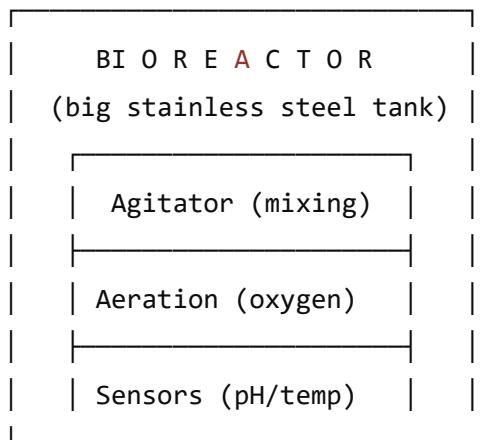
C-IV-T-S-G-P

👉 Cut → Insert → Vector → Transfer → Select → Grow → Purify

★ Bioreactors (Large-Scale Production Tanks)

Used for making insulin, vaccines, hormones, enzymes.

Simple Diagram (Mind Image):



★ Downstream Processing

Purification → Separation → Packaging.

Used for medicines like **insulin**, vaccines, antibiotics.

CHAPTER 2 – BIOTECHNOLOGY & ITS APPLICATIONS

★ MAIN APPLICATIONS

1 Agriculture: Genetically Modified Crops

Examples:

- **Bt cotton** → insect resistant
- **Golden rice** → Vitamin A
- **FlavrSavr tomato** → slower rotting

👉 *GM crops = superheroes with special abilities.*

👉 Bt Cotton (MOST IMPORTANT)

Bt = *Bacillus thuringiensis*

Produces **Cry proteins** → kills cotton bollworm.

Exam Diagram:

Bt gene → inserted into cotton → cotton makes Cry toxin → worms die.

2 Medicine

- Insulin production (human insulin gene inside bacteria)
 - Gene therapy → ADA deficiency
 - Vaccines → Hepatitis B (recombinant DNA vaccine)
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3 Industry

- Enzymes (lipase, protease)
 - Biofuels
 - Bioplastics
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4 Forensics & Diagnostics

- DNA fingerprinting
 - PCR
 - ELISA test
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★ SECTION 2: KEY CONCEPTS & FORMULAS

Important Definitions

Term	Simple Definition
Biotechnology	Using living organisms to make useful products
Recombinant DNA	DNA made by joining DNA from two organisms
Vector	DNA vehicle to transfer gene
PCR	DNA photocopy machine
Transformation	Uptake of foreign DNA into host cell
Selectable marker	Identifies transformed cells

★ Mnemonics

Tools of rDNA tech:

"R-V-H" → Restriction enzymes, Vectors, Host

Steps of rDNA technology:

CIVTSGP (Cut, Insert, Vector, Transfer, Select, Grow, Purify)

★ SECTION 3: SOLVED NUMERICAL PROBLEMS

Biology rarely includes numerical problems except PCR amplification, restriction fragment length, and log scale growth.

1 PCR Numerical

Q. A DNA sample undergoes 5 PCR cycles. How many copies?

Formula:

$$\text{Copies} = 2^n$$

Solution:

$$n = 5$$

$$\text{Copies} = 2^5 = 32 \text{ copies}$$

2 Restriction Enzyme Fragment Calculation

EcoRI cuts DNA at 3 positions.

Number of fragments = number of cuts + 1

$$= 3 + 1$$

= 4 fragments

3 Bacterial Growth Problem

If bacteria double every 20 minutes, find number after 1 hour starting with 2.

$$1 \text{ hour} = 60 \text{ min} = 3 \text{ cycles}$$

$$\text{Final} = \text{Initial} \times 2^3 = 2 \times 8 = 16 \text{ bacteria}$$

★ SECTION 4: PREVIOUS YEARS' BOARD QUESTIONS (SOLVED)

1 Explain the role of restriction enzymes.

Restriction enzymes cut DNA at specific palindromic sequences → produce sticky/blunt ends → useful for making recombinant DNA.

2 Describe the structure of a plasmid vector.

Contains:

- ORI
 - Selectable markers
 - Cloning sites
 - Sometimes reporter genes
- Plasmids replicate independently.
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3 What is Bt Cotton? How does it work?

Contains Cry gene from *B. thuringiensis*.

In insect gut → alkaline pH → toxin activated → insect dies.

4 What is PCR? Write steps.

Steps:

1. Denaturation
 2. Annealing
 3. Extension
- Used in DNA amplification, diagnosis.
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5 How is insulin produced using recombinant DNA?

Two insulin chains (A & B) produced separately in *E. coli* → purified → chemically joined → human insulin.

★ SECTION 5: QUICK REVISION NOTES (2-PAGE STYLE)

🔥 Ultra-Fast Summary: Biotechnology

- Restriction enzymes = scissors
- Ligase = glue
- Vector = vehicle
- Host = factory
- Bioreactor = large tank
- Downstream processing = purification
- GM crops = crops with added genes
- Bt cotton = Cry toxin gene

- Golden rice = Vitamin A
 - Gene therapy = ADA deficiency
 - PCR = DNA photocopy machine
 - DNA fingerprinting uses minisatellites
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Important Diagrams to Practice (Board-Focused)

- ✓ pBR322 vector
 - ✓ PCR cycle
 - ✓ Bioreactor
 - ✓ rDNA steps
 - ✓ Bt cotton mechanism
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★ SECTION 6: PREDICTED / LIKELY BOARD QUESTIONS 2025

1 Mark

- Define recombinant DNA.
- Name the enzyme used to join DNA fragments.
- What is ORI?
- What is gene therapy?

2–3 Marks

- Explain Bt cotton.
- Steps of PCR.
- Methods of gene transfer.
- Applications of biotechnology.

5 Marks

- Explain steps of recombinant DNA technology.
 - Explain the process of insulin production.
 - Describe various applications of biotechnology in agriculture.
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★ SECTION 7: EXAM TIPS & TRICKS

Scoring Tips

- Always draw diagrams → each adds 1–2 marks.
- Underline keywords.
- Write steps in order (C-IV-T-S-G-P).
- For long answers, make a flowchart first.

Common Mistakes to Avoid

- Mixing "bioreactor" and "biosensor"
- Writing Bt cotton as virus gene (it is from bacteria!)
- Forgetting ORI in plasmid structure
- Writing PCR steps out of order

Time-Saving Strategy

For 5-mark questions:

- Write definition (1 mark)
 - Draw diagram (2 marks)
 - Write steps (2 marks)
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SECTION 8: KID-FRIENDLY VISUAL FLOWCHARTS

COLORFUL MEMORY MAP (Text Form)

