

BIOTECHNOLOGY: PRINCIPLES AND PROCESSES

Biotechnology

- Biotechnology = Use of living organisms, cells, or enzymes to produce useful products and services.
- Modern biotechnology involves **genetic engineering** and **bioprocess engineering**.

Core Principles

- **Genetic Engineering**
 - Altering DNA by adding, removing, or modifying genes.
 - Produces **Recombinant DNA (rDNA)**.
- **Bioprocess Engineering**
 - Large-scale production using microbes/cells in **bioreactors**.

Tools of Recombinant DNA Technology

- **Restriction Enzymes:** Cut DNA at specific recognition sites.
 - Example: **EcoRI**
- **DNA Ligase:** Joins DNA fragments.
- **DNA Polymerase:** Synthesizes DNA.
- **Vectors:** Carry foreign DNA into host cells.
 - Example: **Plasmids, Bacteriophages**
- **Competent Host Cells:** Cells capable of taking up recombinant DNA.

Steps in Recombinant DNA Technology

1. Isolation of DNA
2. Cutting DNA using restriction enzymes
3. Amplification of gene by **PCR (Polymerase Chain Reaction)**
4. Ligation into vector
5. Transfer into host cell (Transformation)
6. Selection of transformants
7. Expression of desired gene
8. Downstream processing (Purification & Packaging)

PCR (Polymerase Chain Reaction)

- Amplifies DNA rapidly.
- Requires:
 - Template DNA
 - Primers
 - dNTPs
 - **Taq DNA Polymerase**
- Steps:
 - Denaturation (94–95°C)
 - Annealing (50–65°C)
 - Extension (72°C)

Bioreactors

- Large vessels for industrial production.
- Maintain:
 - Temperature
 - pH
 - Oxygen
 - Nutrients
- Types:
 - Stirred-tank bioreactor
 - Sparged bioreactor

Downstream Processing

- Separation and purification of the final product.
- Quality testing before marketing.

Important Scientists

- **Stanley Cohen & Herbert Boyer** – Recombinant DNA technology.
- **Werner Arber, Hamilton Smith & Daniel Nathans** – Restriction enzymes.
- **Kary Mullis** – PCR.

Important Terms

- **Clone** – Identical copy of DNA/cell.
- **Vector** – DNA carrier.
- **Host** – Organism receiving foreign DNA.
- **Transformation** – Introduction of recombinant DNA into host.
- **Selectable Marker** – Identifies transformed cells.

Exam Keywords

Restriction Enzyme → DNA Ligase → Vector → PCR → Transformation → Bioreactor → Downstream Processing
Mnemonic

"I Cut And Love To Select Every Product"

- **I** – Isolation of DNA
- **C** – Cutting DNA
- **A** – Amplification (PCR)
- **L** – Ligation
- **T** – Transformation
- **S** – Selection
- **E** – Expression
- **P** – Processing (Downstream)

