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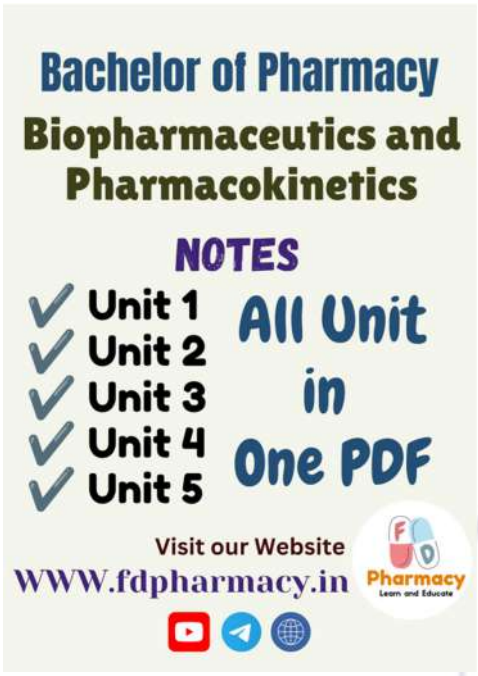
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PHARMACEUTICAL BIOTECHNOLOGY

UNIT 1

TOPIC :

- f) Basic principles of genetic engineering.

Genetic Engineering

Genetic engineering is a branch of biotechnology in which the DNA of an organism is modified by inserting, deleting, or altering specific genes to obtain desired characteristics or useful products.

In simple words, genetic engineering is the technique of cutting, modifying, and joining DNA to produce new genes or proteins.

It is also called:

- Recombinant DNA Technology (rDNA Technology)
- Gene manipulation technology

Definition

- Genetic engineering is the process of artificially modifying the genetic material (DNA) of an organism to produce desired traits or products.

Basic Principle of Genetic Engineering

- The basic principle of genetic engineering is to isolate a desired gene and introduce it into another organism using suitable vectors and enzymes.
- The introduced gene expresses itself in the host cell and produces the desired protein or characteristic.

Components of Genetic Engineering

Main components involved in genetic engineering are:

1. Donor DNA (Desired Gene)
2. Restriction Endonucleases
3. Vector
4. DNA Ligase
5. Host Cell

1. Donor DNA (Desired Gene)

- Donor DNA is the DNA containing the gene of interest that is required for transfer.

Example

- Human insulin gene

Function

- Provides desired genetic information
- Used for production of useful proteins

2. Restriction Endonucleases

- Restriction endonucleases are special enzymes that cut DNA at specific recognition sites.
- They act like molecular scissors.

Functions

- Cut donor DNA
- Cut vector DNA
- Produce sticky or blunt ends

Examples

- EcoRI
- HindIII
- BamHI

3. Vector

- A vector is a DNA molecule used to carry the desired gene into the host cell.

Characteristics of Good Vector

- Self-replicating ability
- Small size
- Easy isolation
- Presence of selectable markers

Types of Vectors

- Plasmids
- Bacteriophages
- Cosmids

4. DNA Ligase

- DNA ligase is an enzyme that joins donor DNA with vector DNA.
- It forms recombinant DNA.

Function

- Joins DNA fragments
- Seals phosphodiester bonds

Formation of Recombinant Dna

$$Desired\ Gene + Vector\ DNA \rightarrow Recombinant\ DNA$$

5. Host Cell

- The host cell is the living cell into which recombinant DNA is introduced.

Examples

- E. coli bacteria
- Yeast cells

Functions

- Replication of recombinant DNA
- Production of desired protein

Steps Involved in Genetic Engineering

Main steps involved are:

1. Isolation of Desired Gene
2. Cutting of DNA
3. Selection of Vector
4. Ligation
5. Introduction into Host Cell
6. Cloning and Expression

1. Isolation of Desired Gene

➢ The useful gene is identified and isolated from donor organism.

Example

- Isolation of insulin gene from human cells.

Purpose

- To obtain specific DNA fragment coding for desired protein.

2. Cutting Of DNA

Restriction endonucleases cut:

- Donor DNA
- Vector DNA

at specific recognition sequences.
This produces compatible ends for joining.

3. Selection of Vector

➢ A suitable vector is selected to transfer the desired gene into host cell.

Common Vectors

- Plasmids
- Bacteriophages
- Cosmids

4. Ligation

➢ The desired gene is joined with vector DNA using DNA ligase enzyme.
➢ This forms recombinant DNA.

5. Introduction Into Host Cell

The recombinant DNA is introduced into host cells.
This process is called:

- Transformation (in bacteria)
- Transfection (in animal cells)

6. CLONING AND EXPRESSION OF GENE

Inside the host cell:

- Recombinant DNA replicates
- Host cells multiply
- Desired protein is produced

Example

Bacteria produce large amounts of recombinant insulin.

Applications of Genetic Engineering

1. Insulin Production

Human insulin is produced using genetically modified bacteria like E. coli.
Advantages:

- Large-scale production
- High purity
- Reduced allergic reactions

2. Vaccine Production

Genetic engineering is used to prepare recombinant vaccines.
Examples

- Hepatitis B vaccine
- HPV vaccine

3. Gene Therapy

Defective genes are replaced with healthy genes to treat genetic disorders.
Applications:

- Cancer treatment
- Inherited disease treatment

4. Production of Enzymes

Genetically modified microbes produce industrial enzymes.
Examples:

- Amylase
- Protease
- Lipase

5. Agricultural Crop Improvement

Genetic engineering helps in development of:

- Pest-resistant crops
- Disease-resistant crops
- High-yield crops

Examples

- Bt cotton
- Golden rice

6. Production of Therapeutic Proteins

Used for production of:

- Growth hormones
- Interferons
- Monoclonal antibodies

Advantages of Genetic Engineering

- Production of useful medicines
- Improved crop yield
- Better disease treatment
- Fast and efficient protein production
- Improved food quality

Disadvantages of Genetic Engineering

- Ethical concerns
- Risk of genetic contamination
- High cost
- Possible environmental hazards