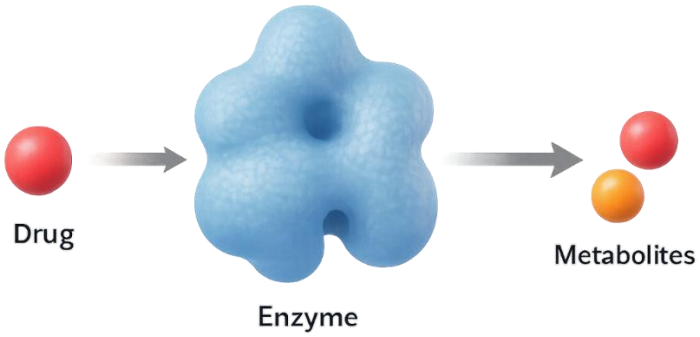
Biotransformation and Transgenesis

Biotransformation

- Biotransformation is the **conversion of a compound into a more useful product using plant cells or enzymes**.



- **Plant enzymes make compounds:**
  - more active
  - less toxic
  - more stable
  - more valuable

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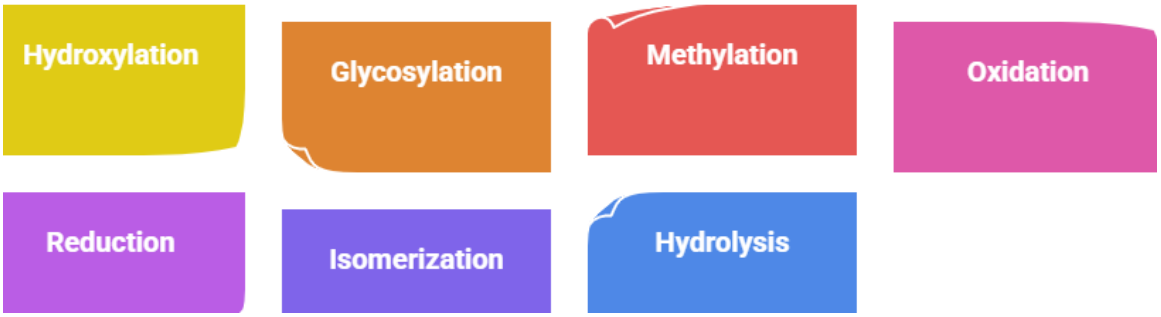
Why It is Important

- Chemical methods are complex, costly, and less pure
- Plant cells perform specific and efficient modifications

Basic Principle

- Add substrates to plant culture
- Enzymes convert it into a new product
- Products are extracted and purified

Common Types of Biotransformation Reactions



A. Hydroxylation

- addition of hydroxyl group
- often increases biological activity

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B. Glycosylation

- addition of sugar group
- may improve solubility and storage

C. Methylation

- addition of methyl group
- may change chemical stability

D. Oxidation

- compound loses electrons or gains oxygen

E. Reduction

- compound gains electrons or hydrogen

F. Isomerization

- one form of compound changes into another form

G. Hydrolysis

- splitting of a compound using water

Where It is Done

- Suspension cultures
- Callus cultures
- Hairy root cultures
- Immobilized cells
- Enzyme systems

Steps

1. Select cell line
2. Grow culture
3. Add substrate
4. Incubate
5. Monitor conversion
6. Extract product

Factors Affecting Process

- Cell type and age
- Substrate concentration
- pH and temperature

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- Oxygen and light
- Elicitors
- Toxicity

Advantages

- High specificity
- Fewer by-products
- Mild conditions
- Useful for complex compounds
- Produces valuable metabolites

Disadvantages

- Slow reactions
- Low yield
- Toxic effects possible
- Difficult scale-up
- Costly recovery

Applications

- Pharmaceutical production
- Modification of alkaloids, steroids, phenolics, terpenoids
- Detoxification
- Flavor and fragrance production
- Study of metabolism

Examples

- Alkaloid formation from precursors
- Glycoside formation from phenolics
- Terpenoid modification
- Transformation in hairy root cultures

Importance

- Acts as a natural biocatalyst
- Convert low-value compounds into high-value products
- Important in drug development and industry

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Bioreactors for Pilot and Large-Scale Cultures of Plant Cells

What is a Bioreactor?

- A bioreactor is a **controlled container** used to grow plant cells in large amounts.
- It controls conditions like **temperature, pH, oxygen, nutrients, and mixing**.

Used for:

- Cell suspension culture
- Hairy root culture
- Somatic embryos
- Secondary metabolite production
- Biotransformation

Why Bioreactors are Needed

- Lab flasks are too small for production
- **Bioreactors allow:**
  - Large-scale growth
  - Better control
  - Continuous monitoring
  - Uniform conditions

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Scale Levels

A. Pilot Scale

- Middle stage between lab and industry
- Used to test and improve the process

B. Large Scale

- Used for commercial production
- Includes large tanks and automated systems

Functions of a Bioreactor

- Keeps system sterile
- Provides nutrients and oxygen
- Controls temperature and pH
- Mixes medium properly
- Removes waste

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- Help collect products

Basic Parts of a Bioreactor

- Culture vessel
- Air inlet and outlet
- Mixing system
- Temperature and pH control
- Sensors and sampling port

Special Problems in Plant Cell Bioreactors

- Plant cells are larger and more delicate than microbial cells.
- Plant cells grow slowly.
- They often form clumps.
- They are sensitive to strong mixing.
- Too much stirring can damage them.
- Oxygen transfer may be difficult in dense cultures.

Pilot vs Large Scale Bioreactors

A. Pilot Scale:

- Medium-sized
- Studies growth, oxygen need, and risks

B. Large Scale:

- **Used for commercial production of:**
  - Medicines
  - Biomass
  - Plantlets and embryos

Applications of Plant Cell Bioreactors

- Secondary metabolite production
- Micropropagation
- Hairy root culture
- Somatic embryogenesis
- Production of pigments, flavors, drugs

Important Factors for Success

- Sterility

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