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PHARMACEUTICAL BIOTECHNOLOGY

UNIT 1

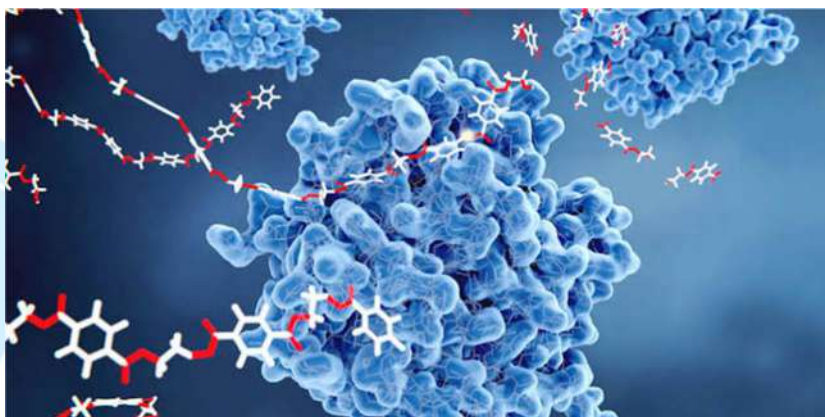
TOPIC :

- b) Enzyme Biotechnology- Methods of enzyme immobilization and applications.



Enzymes

- Enzymes are biological catalysts that increase the speed of chemical reactions in living organisms without themselves being consumed during the reaction.
- Most enzymes are made up of proteins and are highly specific in action.



Characteristics of Enzymes

- Protein in nature
- Highly specific
- Increase reaction rate
- Work under mild temperature and pH
- Reusable in reactions
- Not consumed during reaction

Enzyme Immobilization

- Enzyme immobilization is the process of fixing or attaching enzymes onto a solid support or within a matrix while retaining their catalytic activity.
- The immobilized enzyme cannot move freely but continues to perform its function effectively.

Importance of Enzyme Immobilization

- Enzymes can be reused many times
- Easy separation of enzyme from product
- Better enzyme stability
- Continuous industrial production possible
- Cost-effective for industries
- Reduces contamination of products

Advantages of Enzyme Immobilization

- Reusable and economical
- Easy purification of products
- Increased enzyme stability
- Better control of reaction
- Suitable for continuous processing
- Reduced operational cost

Disadvantages of Enzyme Immobilization

- Initial setup cost is high
- Some loss of enzyme activity may occur
- Preparation methods are complex
- Certain enzymes become unstable
- Diffusion limitations may reduce reaction speed

Methods of Enzyme Immobilization

Main methods include:

1. Adsorption Method
2. Covalent Bonding
3. Cross-Linking
4. Entrapment
5. Encapsulation

1. Adsorption Method

In this method, enzymes are attached to the surface of support materials by weak physical forces such as:

- Van der Waals forces
- Hydrogen bonding
- Ionic interactions

Common support materials:

- Charcoal
- Alumina
- Silica gel

Advantages

- Simple and inexpensive
- No major change in enzyme structure
- Easy preparation

Disadvantages

- Weak bonding
- Enzyme leakage may occur
- Less stable

2. Covalent Bonding Method

→ In this method, enzymes are attached to support materials through strong covalent chemical bonds.

→ It is one of the most commonly used industrial methods.

Support Materials

- Cellulose
- Agarose
- Silica gel

Advantages

- Strong and stable attachment
- Minimal enzyme leakage
- Long operational life

Disadvantages

- Chemical reaction may alter enzyme structure
- Enzyme activity may decrease
- Expensive method

3. Cross-Linking Method

- In this method, enzyme molecules are chemically linked together using bifunctional reagents without using a support material.
- The enzymes form an insoluble network.

Common Cross-Linking Agent

- Glutaraldehyde

Advantages

- High enzyme concentration
- Good stability
- No support material required

Disadvantages

- Chemicals may denature enzymes
- Reduced enzyme activity possible
- Complex preparation

4. Entrapment Method

- In this method, enzymes are trapped inside a gel or polymer matrix.
- The enzyme remains free inside the matrix while substrates and products diffuse through it.

Common Matrices

- Calcium alginate
- Polyacrylamide gel
- Gelatin

Advantages

- Enzyme structure remains unchanged
- Suitable for multienzyme systems
- Better protection of enzymes

Disadvantages

- Large substrate molecules diffuse slowly
- Leakage of small enzymes possible
- Reduced reaction rate

5. Encapsulation Method

- In encapsulation, enzymes are enclosed within a semi-permeable membrane or microcapsule.
- The substrate enters through the membrane and products leave, while the enzyme remains trapped inside.

Materials Used

- Nylon membrane
- Polymer membranes

Advantages

- Good protection from external environment
- Better enzyme stability
- Reduced contamination

Disadvantages

- Membrane slows reaction rate
- Expensive method
- Difficult preparation

Applications of Immobilized Enzymes

1. Pharmaceutical Industry

Used for:

- Antibiotic production
- Drug synthesis
- Steroid transformation

2. Food Industry

Applications include:

- Cheese making
- Lactose-free milk production
- Brewing industry

3. Biosensors

Immobilized enzymes are used in diagnostic devices.

Example:

- Glucose biosensors for blood sugar testing

4. Wastewater Treatment

Used for removal of pollutants and toxic chemicals from industrial waste.