

Introduction to Biotechnology in Pharmaceutical Sciences

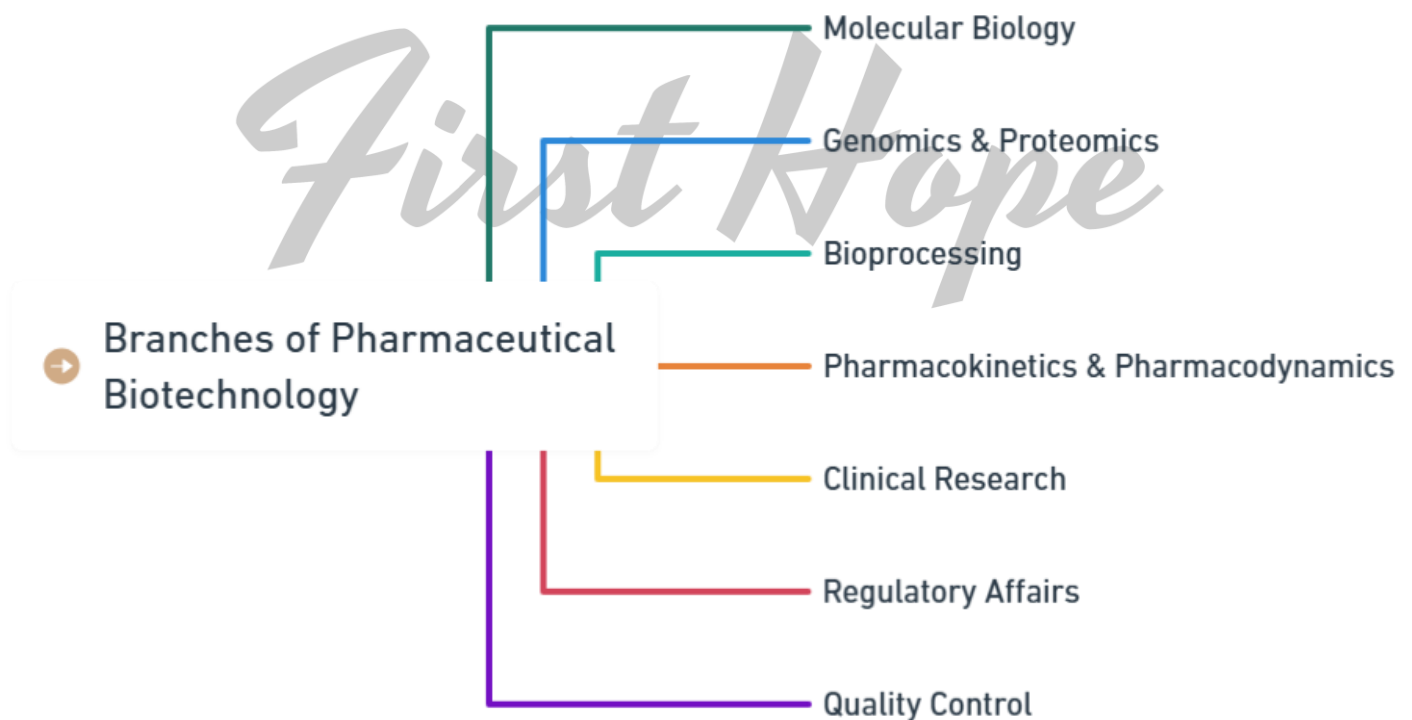
What Is Biotechnology?

- Biotechnology broadly refers to the use of living organisms (bacteria, yeast, mammalian cells, plant cells, etc.) or their components (enzymes, DNA, RNA, and other biomolecules) to develop products and processes that improve human life.
- In the pharmaceutical sciences, biotechnology primarily focuses on discovering, developing, and manufacturing drugs and diagnostics by leveraging biological systems.

History of Pharmaceutical Biotechnology

- Pharmaceutical biotechnology began in the 1970s with recombinant DNA technology, leading to the first biologic drug, human insulin, in 1982.
- Since then, the field has rapidly expanded, introducing biologics, gene therapies, and other advanced treatments.
- Today, biologics represent a major sector of the pharmaceutical industry.

Branches of Pharmaceutical Biotechnology



1. **Molecular Biology** – Studies cellular processes to identify drug targets and develop recombinant DNA and protein-based therapeutics.
2. **Genomics & Proteomics** – Examines genetic and protein expression patterns to enable personalized medicine.
3. **Bioprocessing** – Develops large-scale production methods for biopharmaceuticals like recombinant proteins and vaccines.
4. **Pharmacokinetics & Pharmacodynamics** – Investigates drug absorption, distribution, metabolism, and effects on the body.

5. **Clinical Research** – Designs and conducts trials to evaluate drug safety and efficacy.
6. **Regulatory Affairs** – Ensures compliance with FDA and other regulatory agencies for drug approval.
7. **Quality Control** – Maintains drug quality through rigorous testing and adherence to good manufacturing practices (GMPs).

Objectives of Pharmaceutical Biotechnology

1. **Identifying Drug Targets** – Discovering disease-associated molecules for targeted treatments.
2. **Developing Novel Therapeutics** – Creating biologics and gene therapies for complex diseases.
3. **Enhancing Drug Efficacy & Safety** – Improving formulations to increase effectiveness and reduce toxicity.
4. **Personalized Medicine** – Tailoring treatments to individual genetic profiles.
5. **Large-Scale Drug Manufacturing** – Developing cost-effective bioprocessing techniques.
6. **Clinical Trials** – Testing new drugs for safety and effectiveness.
7. **Regulatory Approval** – Navigating complex drug approval frameworks.

Applications of Pharmaceutical Biotechnology

- **Biologics Development** – Monoclonal antibodies, vaccines, and gene therapies.
- **Recombinant Protein Production** – Insulin, growth hormones, and other therapeutic proteins.
- **Gene Editing Technologies** – CRISPR-Cas9 for genetic disease treatments.
- **Biosimilars Production** – Cost-effective alternatives to existing biologic drugs.
- **Nanotechnology in Drug Delivery** – Enhancing targeted treatment efficiency.
- **Personalized Medicine** – Custom therapies based on genetic profiles.
- **Regenerative Medicine** – Using stem cells to repair tissues and organs.
- **Optimizing Drug Discovery** – Improving efficiency with biotechnological advancements.

Enzyme Biotechnology - Methods of Enzyme Immobilization and Applications

Role of Enzymes in Pharmaceutical Biotechnology

- Enzymes act as biological catalysts, accelerating chemical reactions in drug manufacturing and diagnostics with high specificity and efficiency under mild conditions.
- In pharmaceuticals, enzymes are used to:
 - **Synthesize complex molecules** (e.g., chiral intermediates, antibiotics, drug precursors).

- **Facilitate diagnostics** as key components in diagnostic kits.
- **Modify drugs** through conjugation and other reactions.

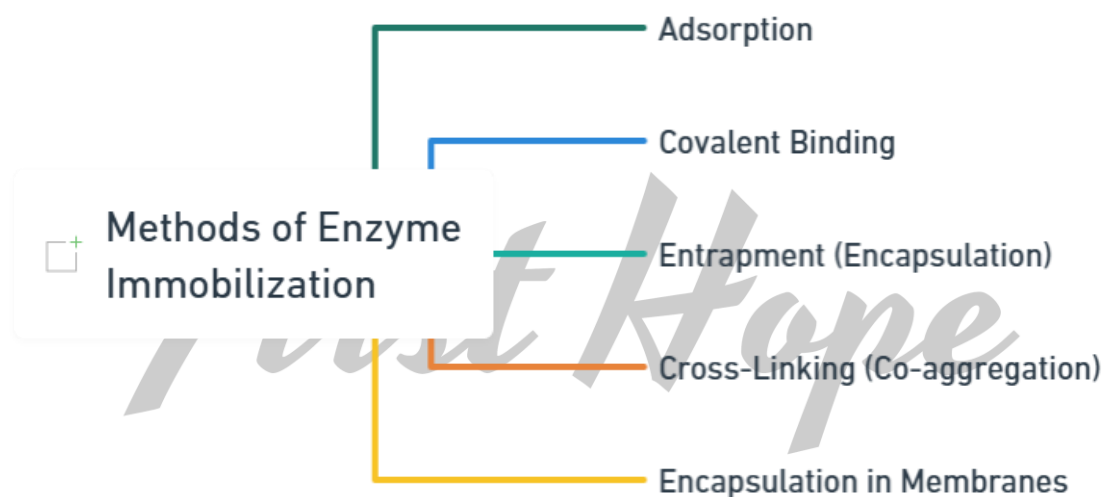
Why Immobilize Enzymes?

- Free enzymes in solution pose challenges such as:
 - Difficulty in separation from the final product.
 - Sensitivity to denaturation under process conditions.
 - High costs due to limited reusability.

Immobilization

- attaching enzymes to a support or trapping them in a matrix—enhances enzyme stability, enables reuse, and improves cost-effectiveness for industrial applications.

Methods of Enzyme Immobilization



1. Adsorption

- The enzyme is physically adsorbed onto a solid support (e.g., activated charcoal, silica, glass beads).
- **Advantages:** Simple, inexpensive, minimal impact on enzyme activity.
- **Disadvantages:** Weak bonding, enzyme may leach out.

2. Covalent Binding

- The enzyme is chemically bonded to a solid carrier (e.g., polymers, glass, cellulose).
- **Advantages:** Strong bonding, high stability.
- **Disadvantages:** May alter enzyme activity, complex process.

3. Entrapment (Encapsulation)

- The enzyme is physically trapped in a gel or polymeric network (e.g., alginate beads, polyacrylamide gel).
- **Advantages:** Protects enzyme, good stability.



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