

Microbial Biotransformation

Microbial Biotransformation

Basic Idea

- Microbial biotransformation is the use of microorganisms such as bacteria, fungi, or yeast to chemically change a substance into another useful substance.
- Microorganisms contain enzymes that can carry out specific chemical reactions in a simple and controlled way.
- This method is widely used in the pharmaceutical industry to produce important medicines.
- Microbial biotransformation is especially useful for making complex drug molecules that are difficult to prepare by ordinary chemical methods.

Why Microbial Biotransformation is Important

- It helps in producing drugs with high purity.
- It reduces the number of chemical steps needed in drug synthesis.
- It is cost-effective for industrial production.
- It works under mild conditions such as normal temperature and pressure.
- It produces fewer harmful chemical wastes and is more environmentally friendly.
- It is useful for producing compounds with specific three-dimensional structures.

Role of Microorganisms

1. Bacteria

- Bacteria can perform oxidation, reduction, and hydrolysis reactions.
- Different bacterial species are selected depending on the required chemical change.

2. Fungi

- Fungi are commonly used because they produce powerful enzymes.
- They are very useful in steroid transformation reactions.

3. Yeast

- Yeast is often used for reduction reactions.
- Yeast can produce compounds with specific stereochemistry.

Types of Reactions in Microbial Biotransformation

1. Oxidation

- In oxidation reactions, oxygen is added or hydrogen is removed from a molecule.
- Microorganisms use enzymes called oxidases for this process.

2. Reduction

- In reduction reactions, hydrogen is added or oxygen is removed.
- These reactions are useful for producing alcohols and chiral compounds.

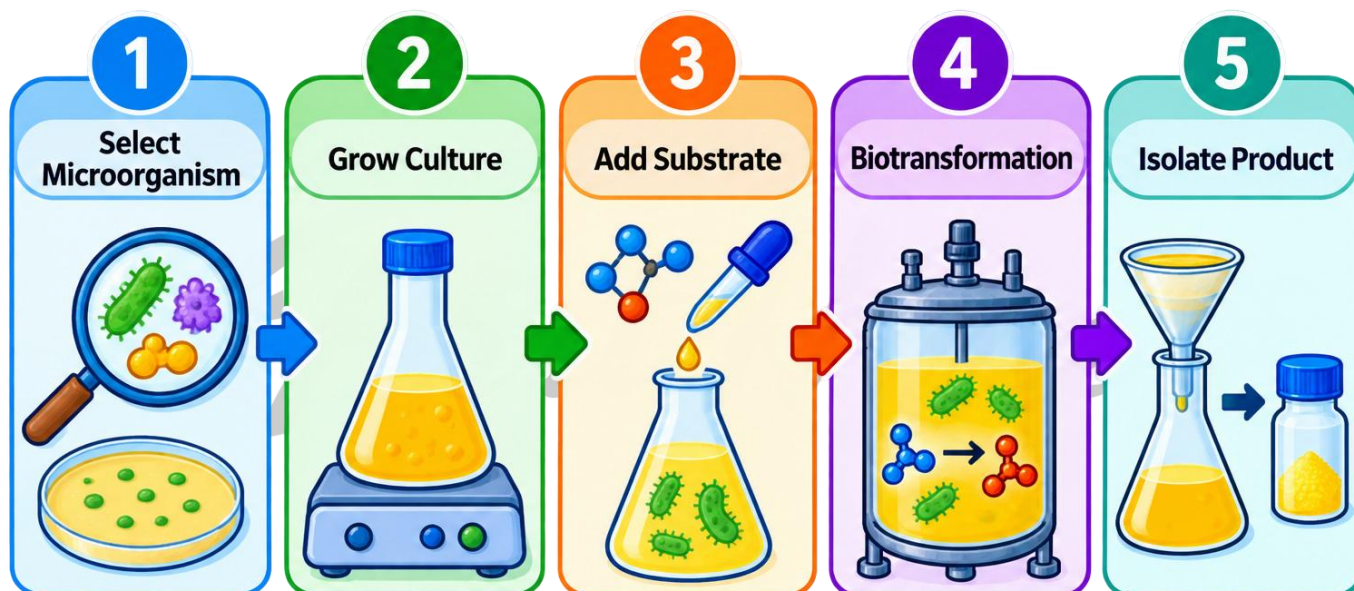
3. Hydrolysis

- Hydrolysis breaks chemical bonds using water.
- Enzymes such as esterases and lipases help in this process.

4. Hydroxylation

- Hydroxylation introduces a hydroxyl group into the molecule.
- This reaction is very important in steroid synthesis.

Steps in Microbial Biotransformation



1. Selection of Microorganism

- Scientists select a suitable microorganism for the required reaction.
- Different microorganisms perform different chemical reactions.

2. Preparation of Culture Medium

- The microorganism is grown in a nutrient-rich medium.
- Proper temperature and pH are maintained during growth.

3. Addition of Substrate

- The chemical compound to be modified is added to the culture.
- The compound acts as the substrate for enzymatic reactions.

4. Biotransformation Reaction

- Microbial enzymes convert the substrate into the desired product.

- The reaction occurs under controlled conditions.

5. Isolation of Product

- The final product is separated from the culture medium.
- Purification methods are used to obtain pure compounds.

Advantages

- Microbial reactions are highly specific.
- Unwanted by-products are produced in smaller amounts.
- Complex molecules can be modified easily.
- Production cost can be reduced.
- Large-scale industrial production is possible.

Limitations

- Some microorganisms grow slowly.
- Certain reactions require careful control of pH and temperature.
- Contamination can affect production.
- Some substrates may be toxic to microorganisms.

Biotransformation for the Synthesis of Chiral Drugs

What are Chiral Drugs

- Chiral drugs are drugs that exist in two mirror-image forms called enantiomers.
- These two forms may show different biological activities in the body.
- One form may produce the desired therapeutic effect, while the other form may be less active or harmful.

Importance of Chirality

- The human body can recognize differences between enantiomers.
- One enantiomer may fit properly into receptors or enzymes, while the other may not fit correctly.
- Therefore, pharmaceutical companies try to produce the active enantiomer in pure form.

Role of Microbial Biotransformation in Chiral Drug Synthesis

- Microorganisms contain stereospecific enzymes.
- These enzymes selectively produce one enantiomer over the other.
- This process is called stereoselective biotransformation.

- The method helps in obtaining drugs with high optical purity.

Common Methods Used

1. Asymmetric Synthesis

- Microbial enzymes convert non-chiral compounds into chiral compounds.
- Only one desired stereoisomer is formed in large quantity.

2. Resolution of Racemic Mixture

- A racemic mixture contains equal amounts of two enantiomers.
- Microorganisms selectively react with one enantiomer and leave the other unchanged.
- This helps in separating the desired active form.

Examples of Chiral Drug Synthesis

1. Production of Antibiotics

- Certain microorganisms help in producing chiral intermediates used in antibiotics.

2. Production of Anti-inflammatory Drugs

- Enzymatic reduction reactions are used to prepare active chiral forms.

3. Production of Beta-blockers

- Microbial enzymes help in producing optically active intermediates.

Advantages in Chiral Drug Production

- High stereoselectivity is achieved.
- Less chemical waste is produced.
- Mild reaction conditions are required.
- The process is environmentally friendly.
- Product purification is becoming easier.

Biotransformation for the Synthesis of Steroids

Basic Idea of Steroid Biotransformation

- Steroids are complex organic compounds used as hormones and medicines.
- Chemical synthesis of steroids is difficult because their structures are very complex.
- Microbial biotransformation simplifies steroid production.

Importance of Steroid Biotransformation

- Microorganisms can introduce chemical groups at specific positions in the steroid molecule.

- These reactions are difficult to achieve by ordinary chemical methods.
- Steroid biotransformation is widely used in pharmaceutical industries.

Common Reactions in Steroid Biotransformation

1. Hydroxylation

- Hydroxyl groups are added at specific positions of the steroid structure.
- This reaction improves biological activity.

2. Dehydrogenation

- Hydrogen atoms are removed from the steroid molecule.
- This reaction changes the activity of steroids.

3. Side-chain Degradation

- Side chains of steroid molecules are shortened or modified.
- This process helps in preparing steroid hormones.

Microorganisms Used in Steroid Production

1. Rhizopus Species

- These fungi are commonly used for hydroxylation reactions.

2. Aspergillus Species

- These fungi help in oxidation reactions.

3. Mycobacterium Species

- These bacteria are used for steroid side-chain degradation.

Examples of Steroid Drugs Produced

1. Cortisone

- Microbial hydroxylation is used in cortisone production.

2. Prednisolone

- Produced through microbial dehydrogenation reactions.

3. Progesterone Derivatives

- Microorganisms help in structural modification of progesterone.

Advantages of Steroid Biotransformation

- Production becomes faster and easier.
- High specificity is obtained.
- Fewer reaction steps are required.

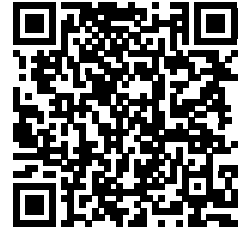


FREE PREVIEW

[Click here to visit our website](#)

PHARMACY PREMIUM NOTES

Complete subject
and semesters are
available on
FirstHope app only.



[Scan or click here](#)

Click here to get the app



Available on Google Play

JOIN THE FIRSTHOPE COMMUNITY

Join our Telegram channel

Click here to join Telegram



[Scan or click here](#)

@FirstHopeNotes

Instagram

@firsthope.official

[Click here to follow >](#)

YouTube channel

FirstHope-Pharmacy / Live streams

[Click here to watch >](#)

WhatsApp channel

Follow FirstHope on WhatsApp

[Click here to join >](#)

FirstHope website

firsthopenotes.com

[Click here to visit >](#)

B.Pharm / D.Pharm / M.Pharm / Pharm.D

Preview notes. Complete subjects and semesters in the FirstHope app.