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PHARMACEUTICAL BIOTECHNOLOGY

UNIT 1

TOPIC :

- e) Use of microbes in industry. Production of Enzymes- General consideration Amylase, Catalase, Peroxidase, Lipase, Protease, Penicillinase.



Microbes

Microbes or microorganisms are very small living organisms that cannot be seen with naked eyes. They can only be observed under a microscope.

Microbes are present everywhere:

- Air
- Water
- Soil
- Food
- Human body

Some microbes are harmful and cause diseases, while many are useful and beneficial to humans.

Types of Microbes

Main types of microbes include:

1. Bacteria
2. Fungi
3. Viruses
4. Protozoa
5. Algae

1. Bacteria

→ Bacteria are single-celled prokaryotic microorganisms.

Characteristics

- Simple structure
- Rapid multiplication
- Some are beneficial while others are pathogenic

Examples

- Lactobacillus
- E. coli
- Streptomyces

2. Fungi

→ Fungi are eukaryotic microorganisms that include yeasts and molds.

Uses

- Bread making
- Antibiotic production
- Fermentation

Examples

- Yeast
- Penicillium
- Aspergillus

3. Viruses

→ Viruses are very small infectious particles that can reproduce only inside living host cells.

Importance

- Cause diseases
- Used in vaccine production and gene therapy

4. Protozoa

→ Protozoa are unicellular eukaryotic microorganisms.

Examples

- Amoeba
- Plasmodium

Some protozoa are pathogenic and cause diseases.

5. Algae

→ Algae are photosynthetic microorganisms found mainly in water.

Uses

- Food supplements
- Oxygen production
- Industrial products

Uses of Microbes In Industry

Microorganisms are widely used in different industries because:

- They grow rapidly
- Produce useful substances
- Easy to culture
- Cost-effective production possible

Microbes In Food Industry

1. Curd and Yogurt Production

Produced using bacteria like:

- Lactobacillus

These bacteria convert milk sugar into lactic acid.

2. Bread Production

→ Bread is prepared using yeast through fermentation.

→ Yeast releases carbon dioxide which makes bread soft and spongy.

3. Cheese Production

→ Cheese is produced using bacteria and fungi.

4. Fermented Foods

Microbes are used in preparation of:

- Idli
- Dosa batter
- Pickles

Microbes In Pharmaceutical Industry

1. Antibiotic Production

→ Many antibiotics are produced from microbes.

Examples

- Penicillin from Penicillium fungus
- Streptomycin from Streptomyces bacteria

Importance

Antibiotics kill or inhibit harmful bacteria.

2. Vaccine Production

→ Vaccines are prepared using weakened or killed microorganisms.

→ They help develop immunity against diseases.

Examples

- Polio vaccine

- Hepatitis B vaccine

3. Hormone Production

→ Genetically modified microbes are used to produce hormones.

Example

- Recombinant insulin produced using E. coli bacteria
Used in treatment of diabetes mellitus.

4. Vitamin Production

→ Microorganisms produce vitamins such as:

- Vitamin B12
- Riboflavin (Vitamin B2)

Microbes in Alcohol Industry

➤ Yeast is used for alcohol fermentation.

Products

- Alcohol
- Wine
- Beer

Principle

Yeast converts sugars into alcohol and carbon dioxide.

Microbes in Agriculture

1. Biofertilizers

➤ Microbes improve soil fertility.

Example

- Rhizobium fixes atmospheric nitrogen

2. Biopesticides

➤ Microorganisms are used to control harmful insects and pests.

Advantages:

- Eco-friendly
- Safe for environment

Microbes in Waste Treatment

➤ Microbes help in decomposition of organic waste materials.

Applications

- Sewage treatment
- Biogas production

- Pollution control

Production Of Enzymes

- Enzymes are biological catalysts that speed up chemical reactions.
- Industrial enzymes are mainly produced by microorganisms because they:
 - Grow rapidly
 - Produce high yield
 - Easy to culture
- Main microorganisms used:
 - Bacteria
 - Fungi

Steps in Industrial Enzyme Production

1. Selection of Microorganism
2. Fermentation Process
3. Production of Enzymes
4. Extraction and Purification

1. Selection of Microorganism

- Suitable microorganisms are selected based on their ability to produce required enzymes.

Examples

- Bacillus → Amylase
- Aspergillus → Citric acid and enzymes

Characteristics of Good Microorganism

- High enzyme yield
- Fast growth
- Non-pathogenic nature

- Stable production



2. Fermentation Process

- Selected microorganisms are grown in large vessels called fermenters under controlled conditions.

Controlled Conditions

- Temperature
- pH
- Oxygen supply
- Nutrients

Types of Fermentation

a) Submerged Fermentation

- Microorganisms grow in liquid medium.

b) Solid State Fermentation

- Microorganisms grow on solid materials.

3. Production of Enzymes

- During growth, microorganisms produce enzymes either:

a) Intracellular Enzymes

- Remain inside microbial cells.

b) Extracellular Enzymes

- Released outside the cells.
- Most industrial enzymes are extracellular because they are easier to collect.

4. Extraction and Purification

- After fermentation, enzymes are separated and purified.

Methods

Filtration

- Removes solid particles.

Centrifugation

- Separates enzyme-containing liquid.

Purification Techniques

- Used to obtain pure enzyme preparations.

Uses of Industrial Enzymes

Industry	Enzymes Used	Applications
Detergent Industry	Protease, Lipase	Removal of stains
Food Industry	Amylase, Invertase	Food processing
Pharmaceutical Industry	Streptokinase	Blood clot removal
Textile Industry	Cellulase	Fabric processing
Paper Industry	Xylanase	Paper bleaching

Advantages of Microbial Enzyme Production

- High production rate
- Cost-effective
- Easy large-scale production
- Eco-friendly process
- Continuous production possible

Disadvantages

- Contamination risk
- Requires controlled conditions

- Purification process may be expensive

General consideration

1. AMYLASE

Amylase is an enzyme that breaks down starch into simpler sugars such as maltose and glucose.

It is present in:

- Humans
- Plants
- Microorganisms

Amylase is one of the most important industrial enzymes.

Types of Amylase

a) Alpha-Amylase

- Breaks internal bonds of starch molecules.

b) Beta-Amylase

- Produces maltose from starch.

c) Glucoamylase

- Converts starch completely into glucose.

Microorganisms Used

- *Bacillus licheniformis*
- *Bacillus subtilis*
- *Aspergillus niger*
- *Aspergillus oryzae*

Industrial Production of Amylase

- Amylase is mainly produced by submerged fermentation in large fermenters.

Steps

1. Selection of microorganism
2. Fermentation under controlled conditions
3. Filtration of culture medium
4. Purification of enzyme

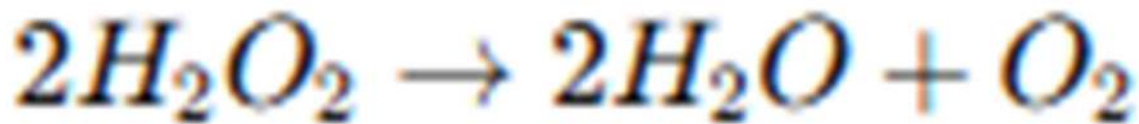
Uses of Amylase

- Bread making
- Brewing industry
- Starch processing

2. Catalase

- Catalase is an enzyme that converts hydrogen peroxide (H₂O₂) into water and oxygen.
- Hydrogen peroxide is toxic to cells, therefore catalase protects cells from oxidative damage.

Reaction



Microorganisms Used

- Aspergillus niger
- Micrococcus luteus
- Bacillus species

Industrial Production of Catalase

- Catalase is produced by fermentation methods.

Steps

1. Growth of microorganisms
2. Fermentation
3. Separation of cells
4. Purification of enzyme

Uses of Catalase

- Textile industry
- Food packaging
- Contact lens cleaning solutions
- Laboratory applications

3. Peroxidase

- Peroxidase is an enzyme that catalyzes oxidation reactions using hydrogen peroxide.
- It is widely used in diagnostics and environmental applications.

Sources

Peroxidase is obtained from:

- Plants such as horseradish
- Microbial fermentation

Industrial Production

Steps

1. Fermentation process
2. Filtration
3. Chromatographic purification

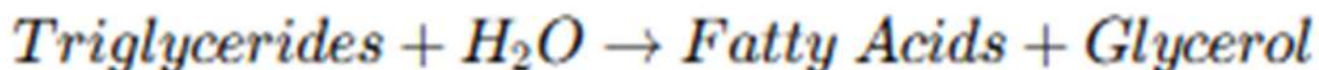
Uses of Peroxidase

- Diagnostic kits
- Blood glucose testing
- Wastewater treatment
- Food industry applications

4. Lipase

- Lipase is an enzyme that breaks down fats (lipids) into fatty acids and glycerol.
- It acts at the interface of oil and water.

Reaction



Microorganisms Used

- *Candida rugosa*
- *Aspergillus niger*
- *Rhizopus oryzae*

Industrial Production of Lipase

Lipase is produced by:

- Submerged fermentation
- Solid-state fermentation

Most lipases are extracellular enzymes and are easy to recover.

Sometimes immobilization is done for reuse.

Uses of Lipase

- Detergents for oil stain removal
- Cheese and dairy products
- Biodiesel production
- Pharmaceutical preparations

5. Protease

- Protease is an enzyme that breaks down proteins into peptides and amino acids.
- Protease is one of the most widely produced industrial enzymes.

Types of Protease

a) Acid Protease

- Functions best in acidic pH.

b) Neutral Protease

- Functions best at neutral pH.

c) Alkaline Protease

- Functions best in alkaline pH.

Microorganisms Used

- *Bacillus subtilis*
- *Aspergillus oryzae*

Industrial Production of Protease

- Protease is produced using large-scale fermentation methods.
- Alkaline proteases are mainly produced for detergent industries.

Steps

1. Fermentation
2. Filtration
3. Purification

Uses of Protease

- Detergent industry
- Leather processing
- Pharmaceutical formulations
- Food industry

6. Penicillinase

- Penicillinase is an enzyme that breaks down penicillin antibiotic by opening its beta-lactam ring.
- It is mainly responsible for bacterial resistance against penicillin antibiotics.

Action of Penicillinase

Penicillin → Inactive Penicilloic Acid

Microorganisms Used

- Staphylococcus aureus
- Bacillus cereus

Industrial Production of Penicillinase

Penicillinase is produced through controlled fermentation processes.

The enzyme may be:

- Intracellular
- Extracellular

After production, the enzyme is extracted and purified.

Uses of Penicillinase

- Research on antibiotic resistance
- Laboratory studies
- Pharmaceutical research

Advantages of Industrial Enzymes

- High catalytic efficiency
- Eco-friendly processes
- Specific action
- Cost-effective production

Disadvantages

- Sensitive to temperature and pH
- Storage problems

- Some enzymes are expensive to purify

