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PHARMACEUTICAL BIOTECHNOLOGY

UNIT 5

TOPIC :

- a) Fermentation methods and general requirements, study of media, equipments, sterilization methods, aeration process, stirring.



Fermentation

Fermentation is a biochemical process in which microorganisms such as bacteria, yeast, and fungi convert sugars and other organic substances into useful products like alcohols, acids, gases, enzymes, vitamins, and antibiotics under controlled conditions.

It is one of the most important industrial microbiological processes and is widely used in:

- Pharmaceutical Industry
- Food Industry
- Biotechnology
- Alcohol Industry
- Agriculture

Definition

- Fermentation is the process in which microorganisms utilize nutrients present in a medium and convert them into useful products through metabolic activities.

Principle of Fermentation

Microorganisms use nutrients present in the culture medium for their growth, reproduction, and metabolism.

During metabolism, they produce valuable products such as:

- Ethanol
- Lactic Acid
- Antibiotics
- Vitamins
- Enzymes
- Organic Acids

The fermentation process is carried out under controlled environmental conditions to maximize product yield.

Components of Fermentation

1. Microorganism

- The microorganism is selected according to the desired product.

Examples

Product	Microorganism
Ethanol	<i>Saccharomyces cerevisiae</i>
Penicillin	<i>Penicillium chrysogenum</i>
Yogurt	<i>Lactobacillus</i> species
Citric Acid	<i>Aspergillus niger</i>

Functions

- Utilizes nutrients.
- Produces desired metabolites.
- Carries out biochemical reactions.

2. Culture Medium

- The culture medium provides nutrients required for microbial growth.

Nutrients Include

Carbon Source

- Glucose
- Sucrose
- Molasses

Nitrogen Source

- Ammonium salts
- Peptone
- Yeast extract

Minerals

- Magnesium
- Phosphorus
- Potassium
- Calcium

Vitamins

- Growth factors for microorganisms

3. Fermenter

- A fermenter is a vessel in which fermentation is carried out.

Functions

- Maintains sterile conditions.
- Controls temperature and pH.
- Provides aeration.
- Facilitates agitation and mixing.

4. Environmental Conditions

- Proper environmental conditions are maintained for optimum growth and product formation.

Important Parameters

- Temperature
- pH
- Aeration
- Agitation
- Nutrient Supply
- Sterility

Stages of Fermentation

1. Preparation of Culture Medium

- A suitable nutrient medium is prepared for microbial growth.

Contains

- Carbon source
- Nitrogen source
- Minerals
- Vitamins

Purpose

- Provides essential nutrients for microorganism growth.

2. Sterilization

- The fermenter, medium, pipelines, and equipment are sterilized.

Purpose

- Prevents contamination.
- Ensures pure culture growth.

Methods

- Steam sterilization
- Autoclaving
- Filtration

3. Inoculation

- The selected microorganism is introduced into the sterile medium.

Purpose

- Initiates the fermentation process.

Requirements

- Aseptic conditions
- Pure microbial culture

4. Incubation

- The inoculated fermenter is maintained under optimum conditions.

Conditions Controlled

- Temperature
- pH
- Oxygen supply
- Agitation

Result

- Microorganisms grow rapidly and produce metabolites.

5. Product Formation

- Microorganisms synthesize the desired product during metabolism.

Examples

- Antibiotics
- Alcohol
- Organic acids
- Vitamins
- Enzymes

6. Recovery and Purification

- The final product is separated from the fermentation broth.

Methods

- Filtration
- Centrifugation
- Extraction
- Chromatography
- Crystallization

Purpose

- Obtains pure product suitable for industrial use.

Types of Fermentation

1. Batch Fermentation

- Nutrients added only at the beginning.
- No additional medium supplied during fermentation.
- Product collected after completion.

Advantages

- Simple operation.
- Less contamination risk.

2. Fed-Batch Fermentation

- Nutrients added periodically during fermentation.
- Improves product yield.

Advantages

- Better control of nutrient concentration.
- Higher productivity.

3. Continuous Fermentation

- Fresh medium continuously added.
- Product continuously removed.

Advantages

- High productivity.
- Suitable for large-scale production.

Applications of Fermentation

1. Pharmaceutical Industry

Production of

- Antibiotics
- Vaccines
- Vitamins
- Enzymes
- Hormones
- Amino acids

Examples

- Penicillin
- Streptomycin
- Vitamin B₁₂

2. Food Industry

Production of

- Bread, Yogurt
- Cheese
- Vinegar, Pickles

Benefits

- Improves flavor.
- Increases shelf life.
- Enhances nutritional value.

3. Alcohol Industry

Production of

- Beer, Wine
- Ethanol
- Spirits

Organism Used

- *Saccharomyces cerevisiae*

4. Biotechnology Industry

Production of

- Recombinant proteins
- Vaccines
- Therapeutic enzymes
- Monoclonal antibodies