PADMASHREE INSTITUTE OF MANEGMENT AND SCIENCE.

Seminar topic on

- **Types Of Fermentation Process ;**

Presented by;

Shylesh murthy I .A

2Nd yr

Msc biotechnology

PIMS

Fermentation

Traditional fermentation

Traditional fermentation technology, as mentioned in the literary texts, is more than **3000 year old in India .**

The fermentation technology employed a variety of processes and was put to a large number of uses. It also laid the foundation of alchemy and chemistry.

The term fermentation is derived from the Latinword ***Fermentum that stands for boiling. Fermentation is the*** process of digesting certain substances that leads to chemical conversion of **organic substances into simpler compounds.**

Fermentation

- Fermentation has been widely used for the production of a wide variety of substances that are **highly beneficial to individuals and industry. Over the years, fermentation** techniques have gained immense importance due to their economic and Environmental advantages.

- Ancient techniques have been further modified and refined to maximize productivity. This has also involved the development of new machinery and processes.
- Two broad fermentation techniques have emerged as a result of this rapid development:

Solid State Fermentation (SSF).

Submerged Fermentation (SmF).

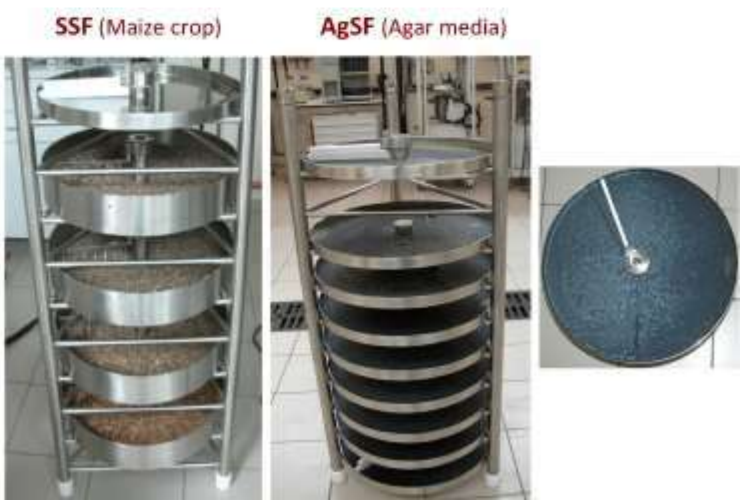
At the research level, both SSF and SmF have been used;however, some techniques yielded better results than others.

Solid State Fermentation

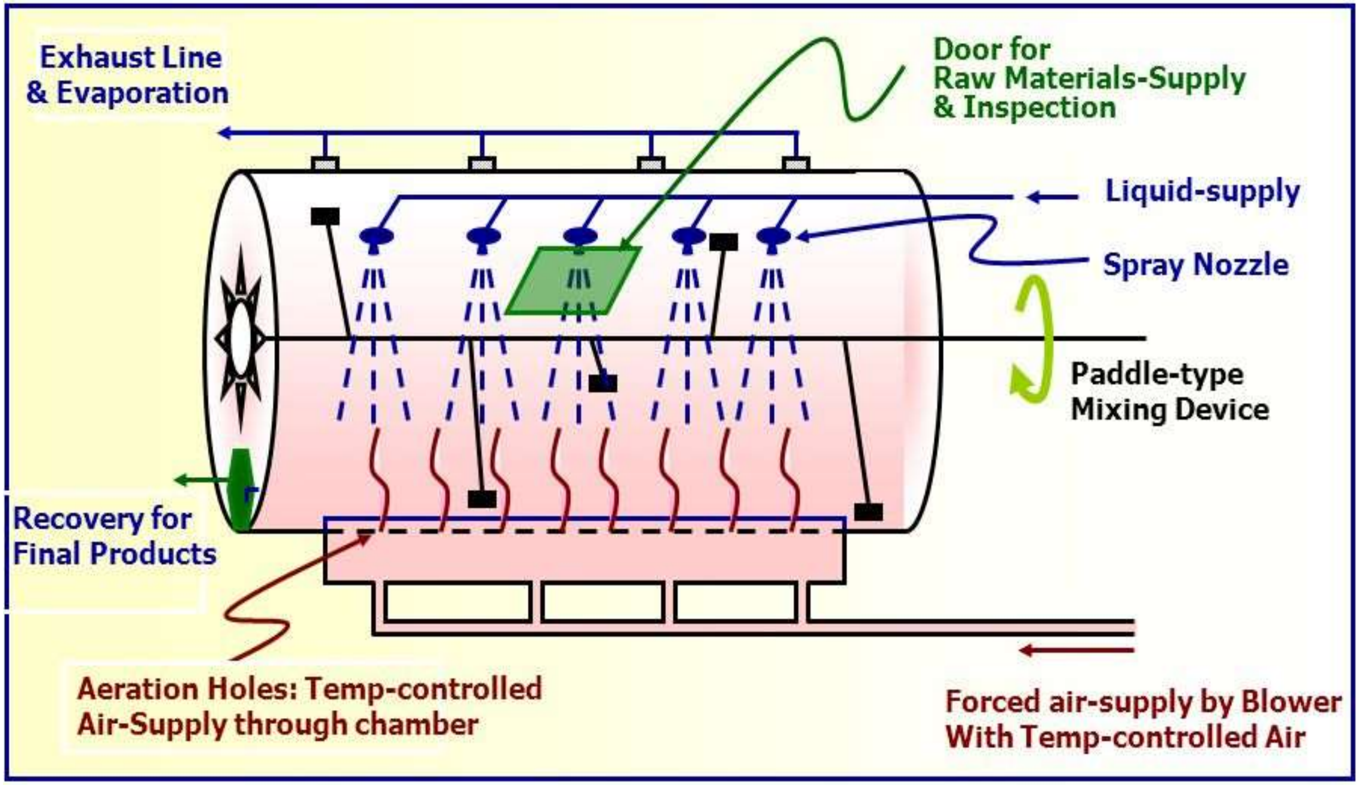
Solid state (substrate) fermentation (SSF) has been defined as the fermentation process occurring in the absence or near-absence of free water.

Solid state fermentation (SSF) is another method used for the production of enzymes, which involves the cultivation of microorganisms on a solid substrate, such as grains, rice and wheat.

SSF employs natural raw materials as carbon source such as assava, barley, wheat bran, sugarcane bagasse.



Design of Solid-state Fermentor



Selection of Micro-organism

This is one of the key factor for improved yields of the product. Bacteria, Yeast and Filamentous Fungi can be used.

Filamentous Fungi has shown better results growing in the solid substrate fermentation.

Substrate

Substrate also plays important role in determining the growth of micro-organisms, there by increasing the product yield.

Substrate is chosen such a way that it should provide physical support as well as nutrients to the growing culture.

Applications:

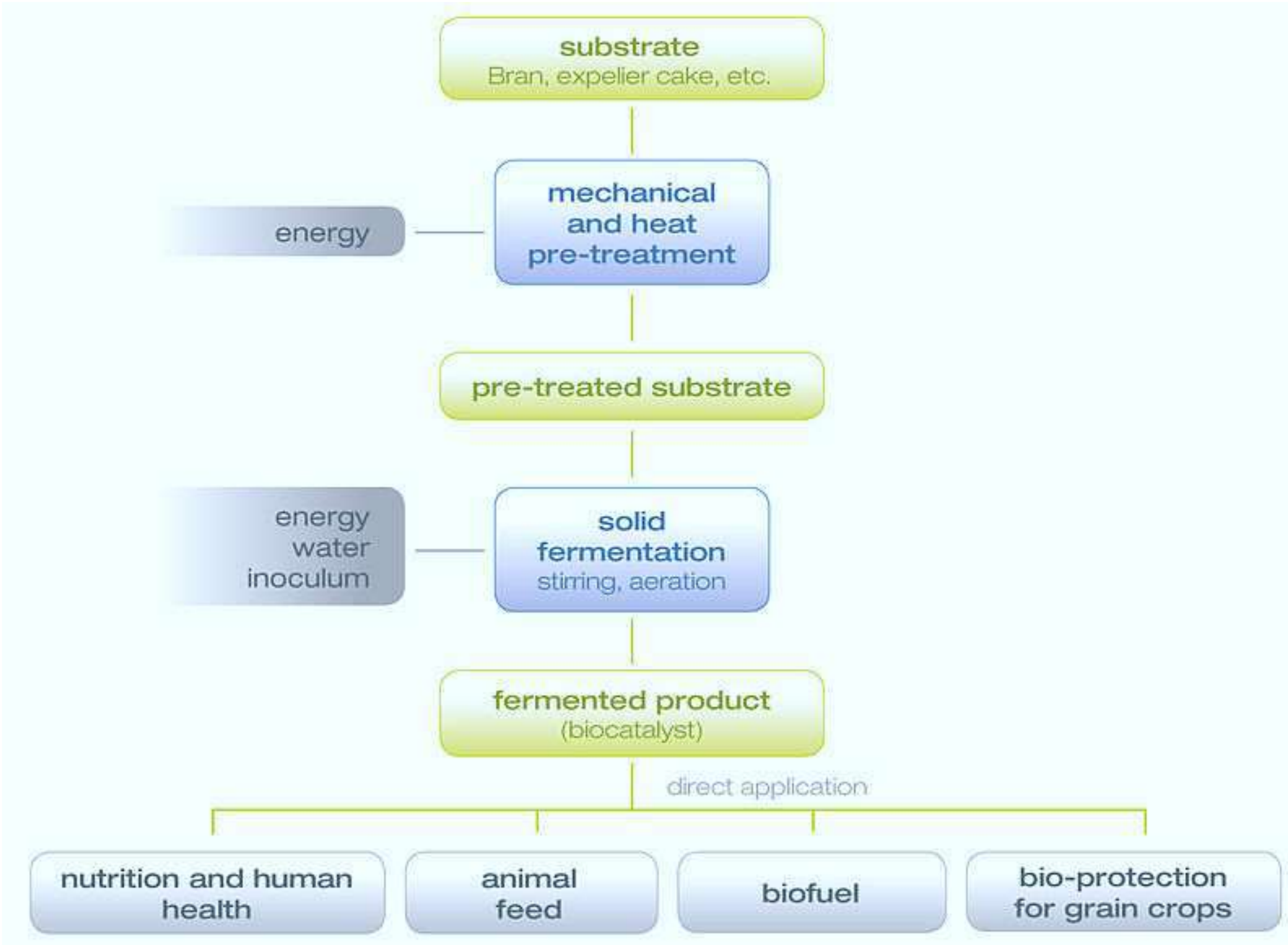
Applications of SSF as described before, Solid State fermentation is being employed in various fields ranging from pharmacology to bioremediation, covering various aspects of biodiversity conservation.

Production of Industrial Enzymes

Production of Bio pesticides

In Bioleaching

In Bioremediation


substrate
Bran, expelier cake, etc.
energy
mechanical
and heat
pre-treatment
pre-treated substrate
energy
water
inoculum
solid
fermentation
stirring, aeration
fermented product
(biocatalyst)
direct application
nutrition and human
health
animal
feed
biofuel
bio-protection
for grain crops

Examples for Solid State Fermentation

EXAMPLE	SUBSTRATE	MICRO ORGANISMS
MUSHROOM PRODUCTS	STRAW, MANURE	AGARICUS BISPORUS
SOY SAUCE	SOYA BEANS AND WHEAT	ASPERGILLUS ORYZAE
CHEESE	MILK CURD	PENICILLUM ROQUEFORTI
TEMPEH	SOYA BEANS	RHIBOPUS OLIGOSPORES
LEACHING OF METALS	LOW GRADE ORES	THIOBACILLUS SP….
ORGANIC ACIDS	CANE SUGAR,MOLASSES	ASPERGILLUS NIGER

Advantage of SSF

A lower chance of contamination due to low moisture levels.

Ease of product separation.

Energy efficiency.

Development of fully differentiated structures.

Submerged fermentation:

In the submerged process, the substrate used for fermentation is always in liquid state which contains the nutrients needed for growth.

The fermentor which contains the substrate is operated continuously and the product biomass is continuously harvested from the fermenter by using different techniques then the product is filtered or centrifuged and then dried.

Submerged fermentation is a method of manufacturing bio molecules in which enzymes and other reactive compounds are submerged in a liquid such as alcohol, oil or a nutrient broth.

The process is used for a variety of purposes, mostly in industrial manufacturing

Applications:

Submerged Fermentation (SmF)/Liquid Fermentation (LF) SmF utilizes free flowing liquid substrates, such as molasses and broths.

This fermentation technique is best suited for microorganisms such as bacteria that require high moisture.

An additional advantage of this technique is that purification of products is easier.

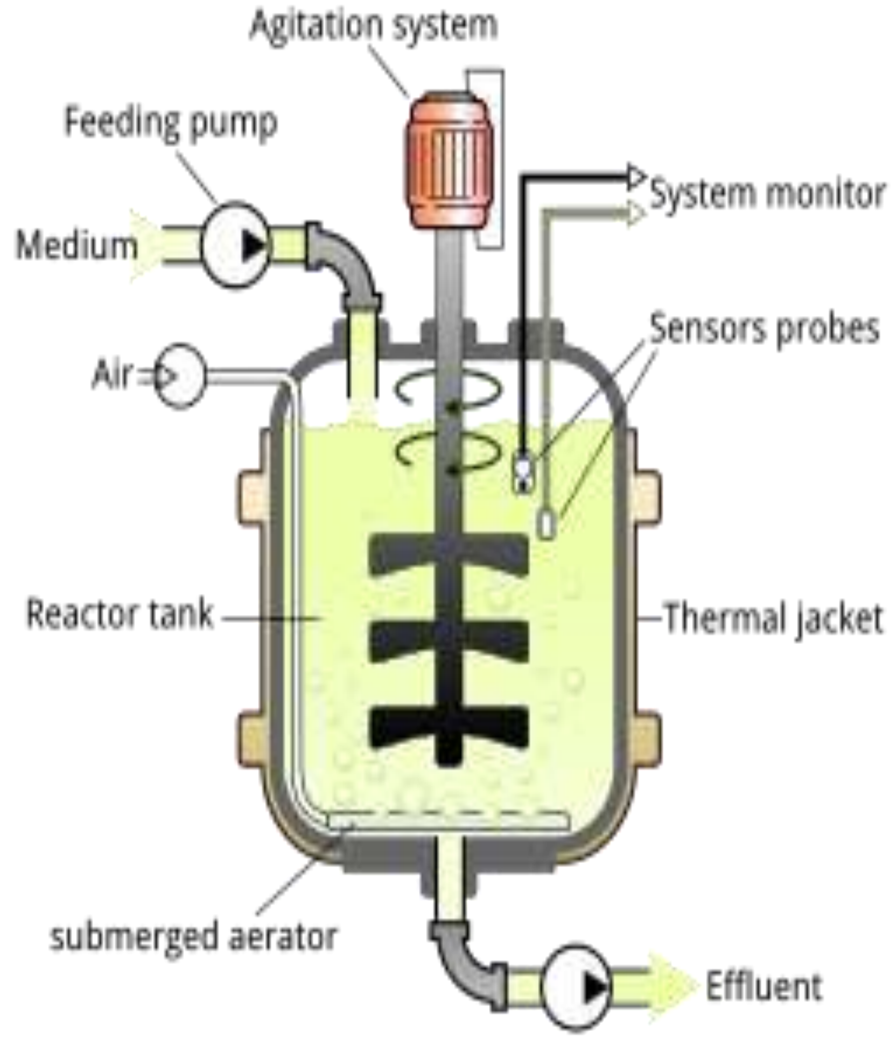
fermentation process .

Batch fermentation

Continuous fermentation

Batch fermentation ;

Nutrients are added in the fermentation for the single time only the growth continuous until the particular nutrient are exhausted.


Agitation system
Feeding pump
Medium
System monitor
Sensors probes
Air
Reactor tank
Thermal jacket
submerged aerator
Effluent

I) Batch Fermentation (also is known as a closed system)

1- The culture is inoculated into the sterile medium contained in a **closed vessel**.

2- No additional nutrients are added once the fermentation process starts (the **nutrients of the medium is neither renewed nor metabolic wastes removed**).

3- Basic controls for **pH, temperature, dissolved oxygen**, and foam of the fermentation medium are **regulated** in this type of fermentation.

4- **Exponential growth** last only for a **few generations**.

5- The **growth rate is not constant** due to lack of stability of the optimal conditions.

6- **Growth curve with four phases** is observed.

7- The products, be they intra**-** or extracellular, are harvested only at the end of the run.

- In the batch process when the microorganism is added into a medium which supports its growth, the culture passes through number of stages known as 'growth curve'

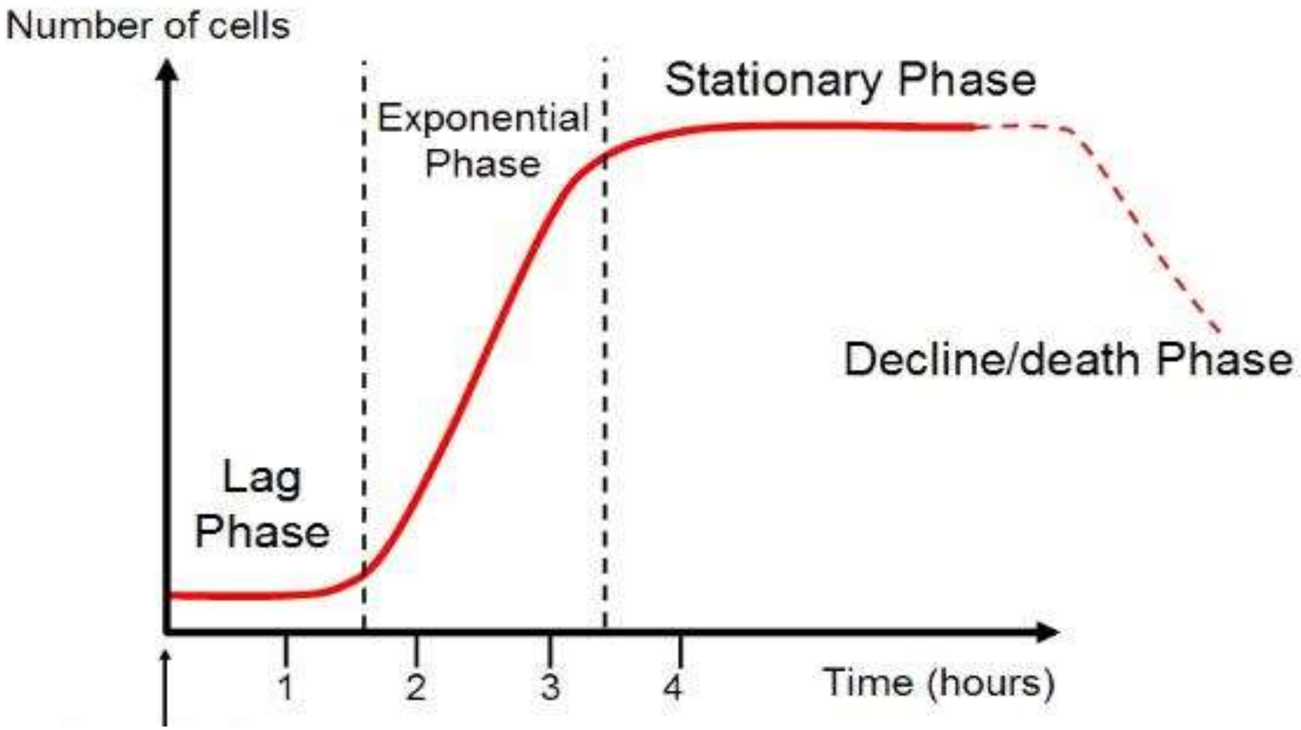
A typical growth curve consists of following stages

a) Lag phase
b) Acceleration phase
c) Log or exponential phase
d) Deceleration phase
e) Stationary phase
f) Death phase

- **(a) Lag phase:**
- Immediately after inoculation, there is no increase in the numbers of the microbial cells for some time and this period is called lag phase. In this is phase the organisms adjust to the new environment in which it is inoculated into.
- **(b) Acceleration phase:**
- The period when the cells just start increasing in numbers is known as acceleration phase.
- **(c) Log phase:**
- This is the time period when the cell numbers steadily increase.
- **(d) Deceleration phase:**
- The duration when the steady growth declines.

- **(e) Stationary phase:**
- The period where there is no change in the microbial cell number is the stationary phase. This phase is attained due to depletion of carbon source or accumulation of the end products.
- **(f) Death phase:**
- The period in which the cell numbers decrease steadily is the death phase. This is due to death of the cells because of cessation of metabolic activity and depletion of energy resources.
- Depending upon the product required the different phases of the cell growth are maintained. For microbial mass the log phase is preferred. For production of secondary metabolites i.e. antibiotics, the stationary phase is preferred.

Bacteria - Population Growth Curve



Characteristics of a batch fermentation system

Simplest fermentor operation

Sterilisation can be performed in the reactor.

All nutrients are added before inoculation .

Maximum levels of C and N are limited by inhibition of cell growth.

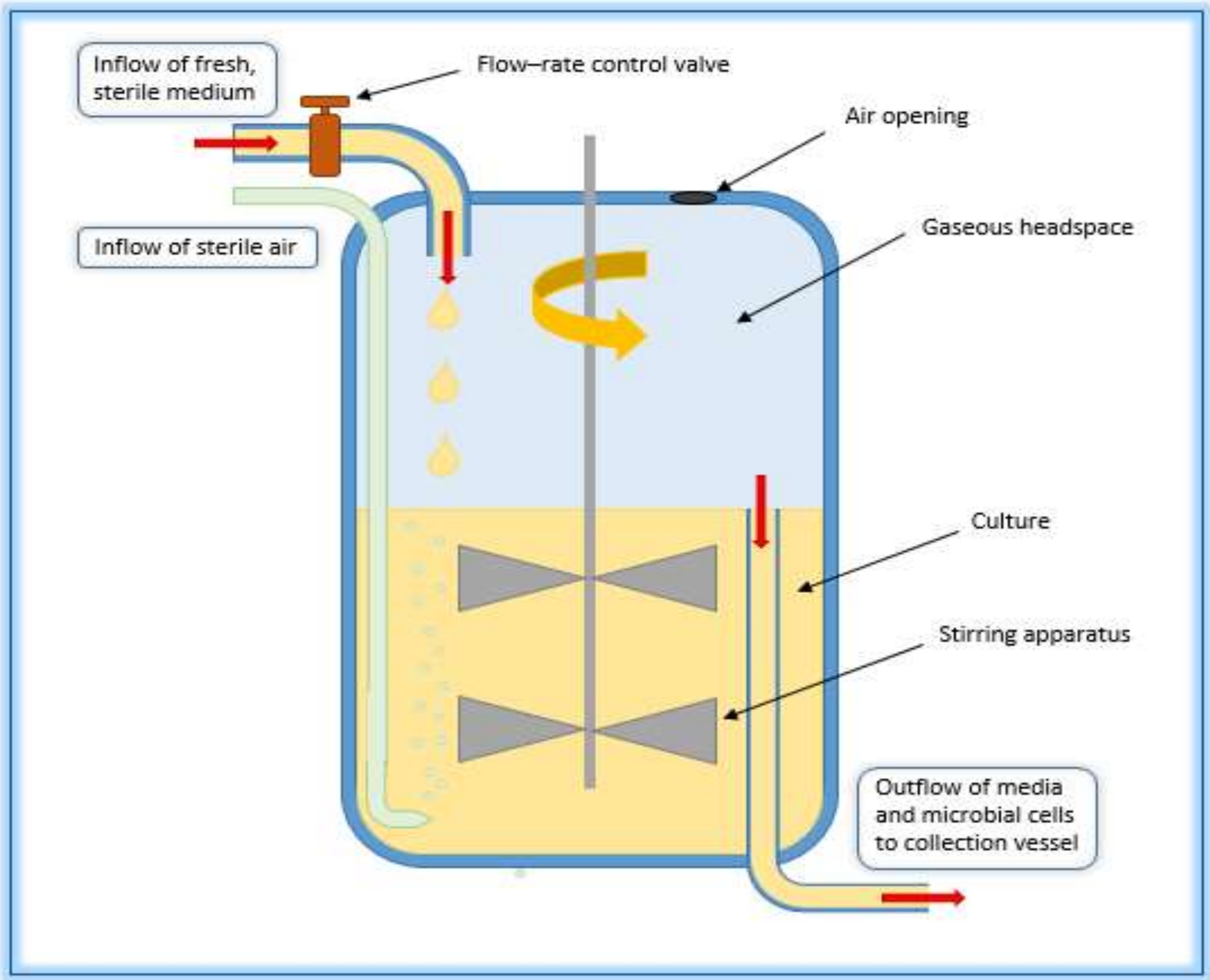
Biomass production limited by C/N load and production of toxic waste products.

CONTINUOUS FERMENTATION

It is a continuous process where the nutrient is continuously added to the fermented at a fixed rate.

The organisms are continuously maintained at logarithmic stage.

The products are recovered continuously.
The fomenters in this type are called " flow through'' fermentation.


Inflow of fresh, sterile medium
Flow–rate control valve
Air opening
Inflow of sterile air
Gaseous headspace
Culture
Stirring apparatus
Outflow of media and microbial cells to collection vessel

Disadvantages of continuous fermentation

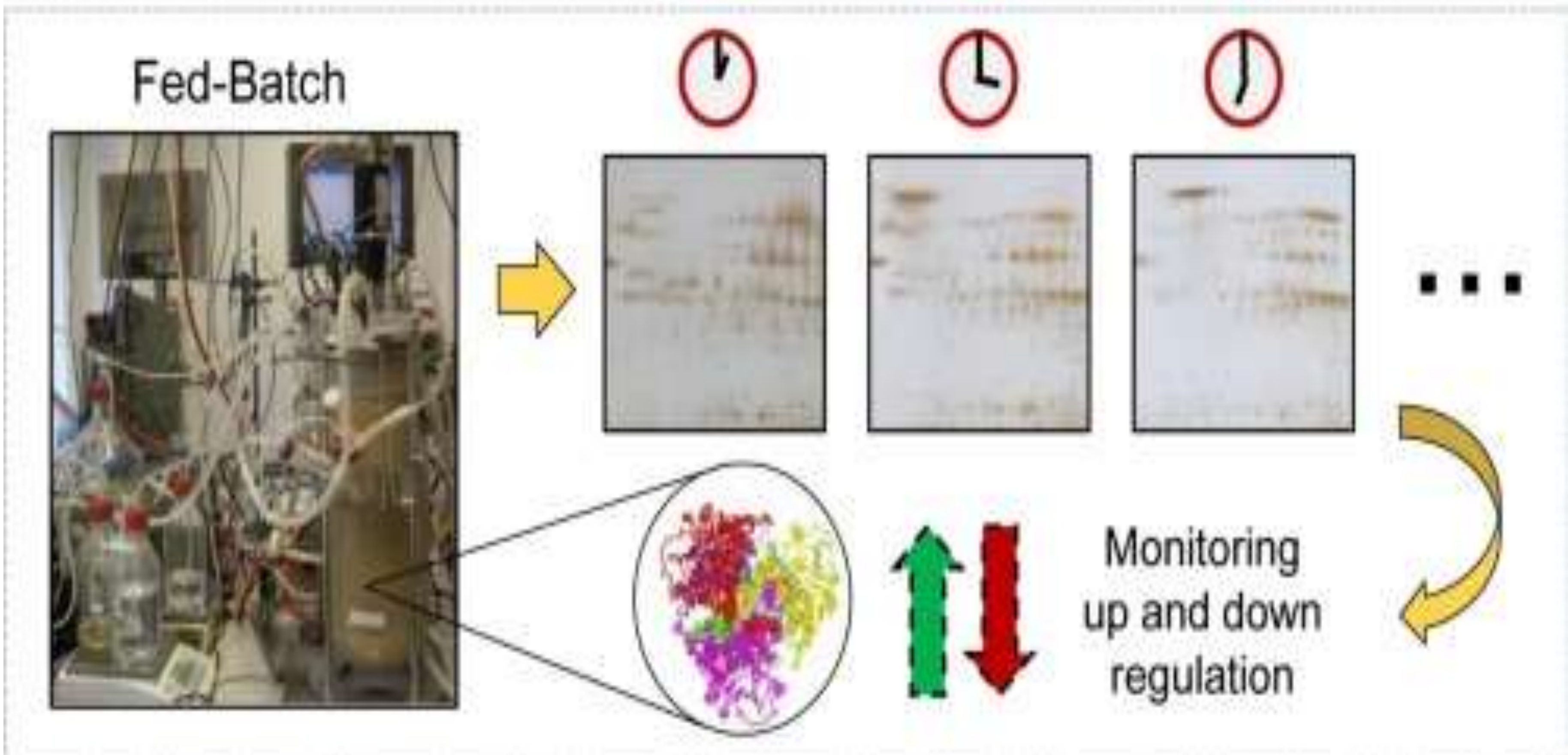
Complete sterilization is difficult.

More prone to contamination.

FED BATCH FERMENTATION

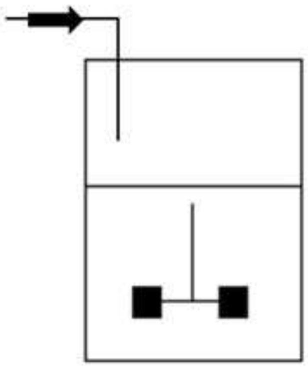
This fermentation is intermediate of both batch and continuous fermentation.

Sterile nutrients are added in increments .

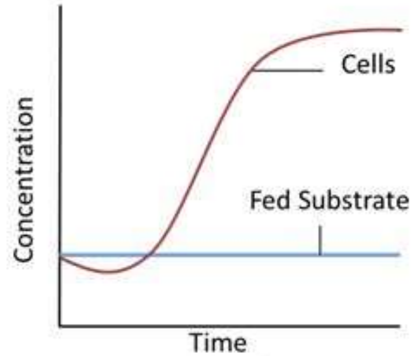

Fed-Batch
Monitoring
up and down
regulation

II. Fed-Batch fermentation

In fed-batch fermentation, fresh growth medium is added continuously during fermentation, and no growth medium is removed until the end of the process.



Batch



Fed-Batch

(1) The continuous addition of medium prolongs both the log and stationary phases, thereby increasing the biomass and the amount of metabolites.

(2) However, microorganisms in stationary phase often produce proteolytic enzymes (proteases) to degrade proteins.

(3) A fed-batch fermentation strategy can increase the yield from 25% to more than 1,000% compared with batch fermentation.

Reasons for Fed-Batch Cultures

- To remove repressive effects of rapidly utilized carbon sources.
- To reduce the toxic effect of some medium components.

Applications of Fed-Batch Cultures

1- **The yeast cell production**

The yeast cell production, in which sugar (glucose) was added periodically during the course of fermentation to maintain a low sugar concentration to suppress alcohol formation.

2- **Penicillin production**

Penicillin fermentation, in which the energy source (e.g., glucose) and precursors (e.g., phenyl acetic acid) were added periodically during the course of fermentation to improve penicillin production.

Thank You!