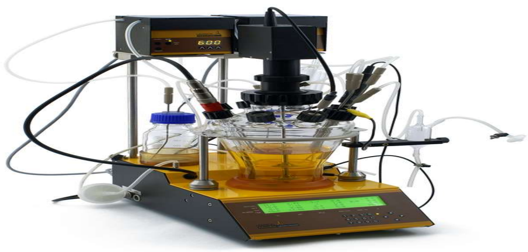
Types of fermenters (batch, fed batch and continuous), functions, design and control; sterilization; growth rate analysis



Fermentation

Fermentation is the process in which a substance breaks down into a simpler substance using organism.

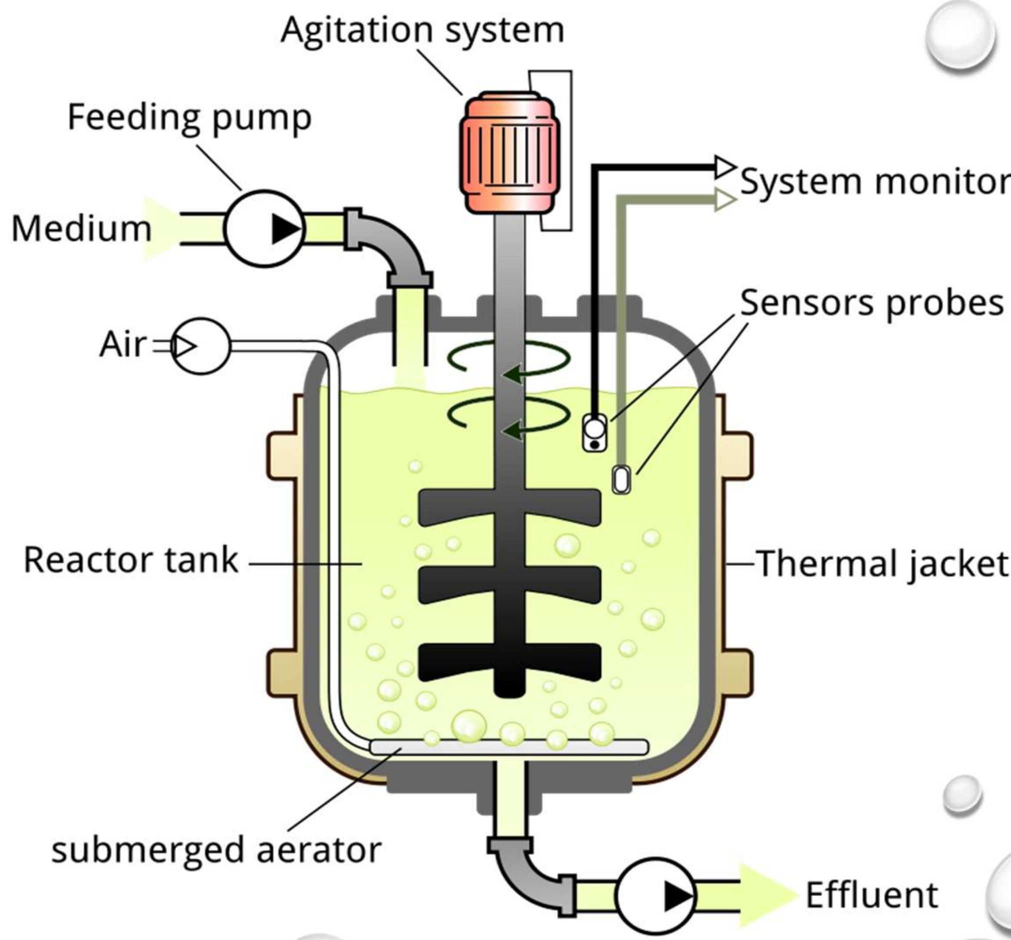
Its biochemical meaning relates to the generation of energy by the catabolism of organic compounds.

Fermentation is a word that has many meanings for the microbiologist:

1. Any process involving the mass culture of microorganisms, either aerobic or anaerobic.
2. Any biological process that occurs in the absence of O_2.

Bioreactor is a device or system in which a chemical process is carried out that supports to maintain a biologically active environment inside that vessel which involves organisms or biochemically active substances derived from specific organisms. This process may either be aerobic or anaerobic. These bioreactors are commonly cylindrical in shape ranging in size from litres to cubic metres and are often made up of stainless steel material.

Fermentation system / process objectives depends on two factors:
Fermentor design and
Fermentation process



Source: https://en.wikipedia.org/wiki/Bioreactor

A typical bioreactor consists of following parts:

Agitator – used for the mixing of the contents of the reactor which keeps the “cells” in the perfect homogenous condition for better transport of nutrients and oxygen to the desired product(s).

Baffle – used to break the vortex formation in the vessel, which is usually highly undesirable as it changes the center of gravity of the system and consumes additional power.

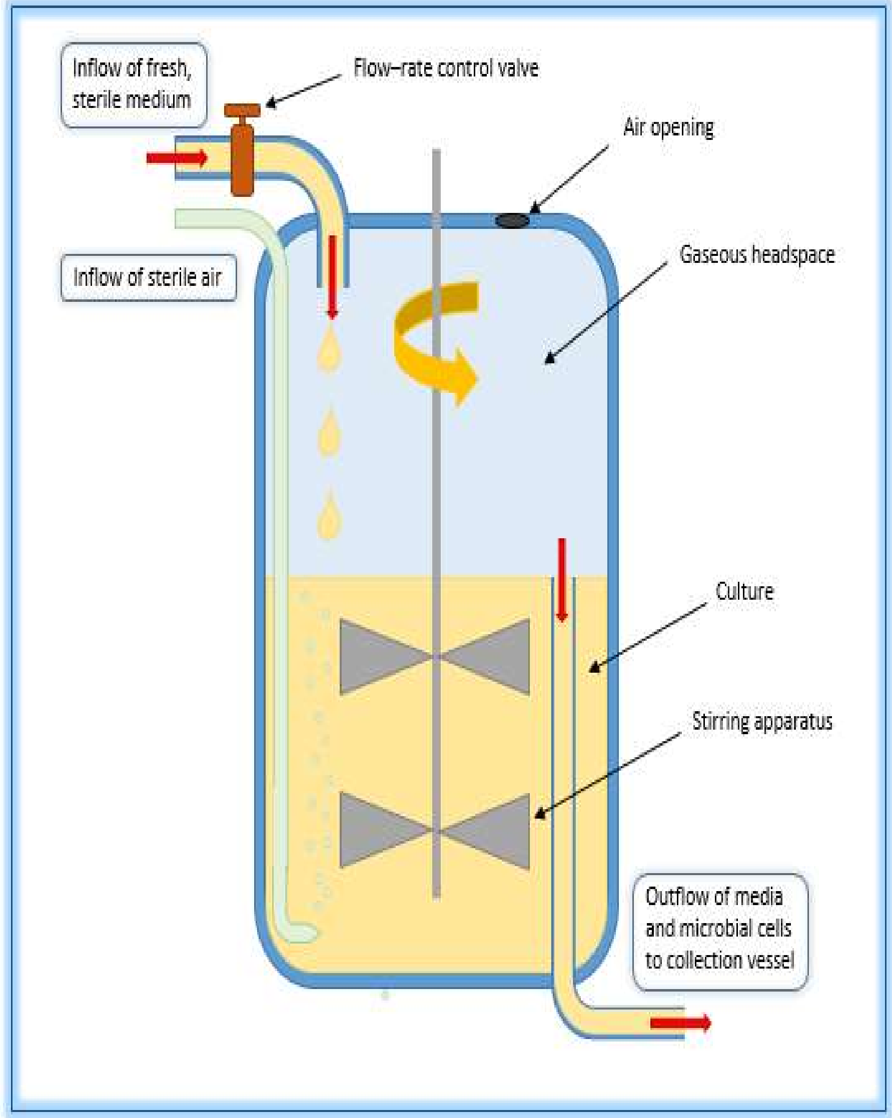
Sparger – In aerobic cultivation process, the purpose of the sparger is to supply adequate oxygen to the growing cells.

Jacket – The jacket provides the annular area for circulation of constant temperature of water which keeps the temperature of the bioreactor at a constant value.

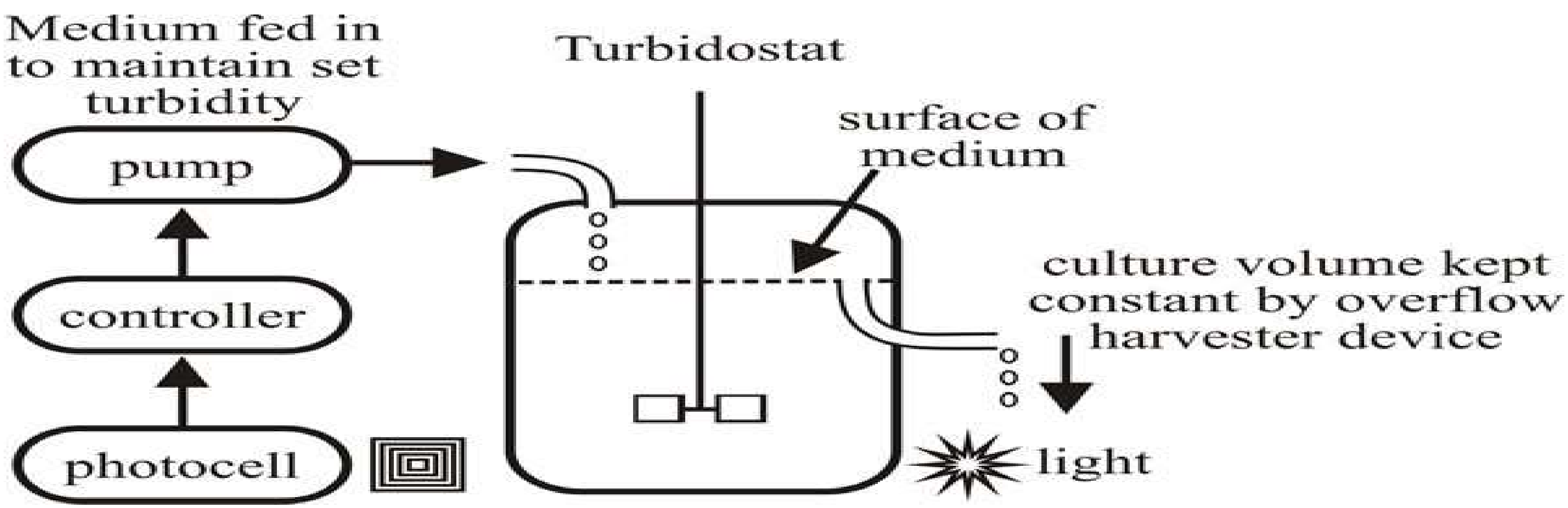
On the basis of mode of operation, a bioreactor may be classified as batch, fed batch or continuous (e.g. a continuous stirred-tank reactor model)

1. The bacteria are inoculated into the bioreactor (always stirred tank bioreactor). 2. Then, under certain conditions (temperature, pH, aeration, etc.) the bacteria go through all the growth phases (lag, exponential, stationary).	1. The fresh medium flows into the fermentor continuously, and part of the medium in the reactor is withdrawn from the fermenter at the same flow rate of the inlet flow. 2. The bacteria is grown under certain conditions (temperature, pH, aeration)
Advantages: • can be used for diff reactions every day. • Safe: can be properly sterilized. • Little risk of infection or strain mutation • Complete conversion of substrate is possible	Advantages: • Works all the time: low labor cost, good utilization of reactor • Often efficient: due to the autocatalytic nature of microbial reactions,. • the productivity can be high. • Automation may be very appealing. • Constant product quality
Dis-advantages: •High labor cost •Much idle time – Sterilization, growth, cleaning •Safety – filling emptying, cleaning.	Dis-advantages: •promised continuous production for months fails due to a. infection. b. spontaneous mutation of microorganisms to non producing strain

- **What is Chemostat?**
- Chemostat is a type of continuous culture system in which a single nutrient/component of the medium controls the growth rate of the microbes. It is an open culture system and has a continuous feed of fresh nutrients at a constant rate. Continuous removal of culture at a constant rate from the other side keeps the volume inside constant. The name 'Chemostat' implies that the growth rate of the chemostat can be controlled by a single component of the culture medium inside the fermenter.
- However, the continuous feed of culture medium fulfills the optimum nutritional requirement. Dilution rate or the rate of adding nutrient always determines the growth rate of the microbes inside the chemostat.



- **What is Turbidostat?**
- Turbidostat is another type of continuous culture system in which internal culture reactions control the specific growth rate. Culture biomass maintains at a constant by measuring the optical density of the culture medium using a photometer. When turbidity comes to a certain level, medium pump switches on and adjusts the turbidity to the required level. Internal culture volume is also at a constant in this system. Furthermore, the growth rate of the microbes does not depend on a single component of the culture medium. Neither does the flow rate remains constant.



What are the Similarities Between Chemostat and Turbidostat?

- Chemostat and turbidostat are continuous culture systems.
- Both of them are open culture systems.
- In both systems, culture volume is constant.
- The environmental conditions are constant in both systems.
- In both systems, culture duration is indefinite.

What is the Difference Between Chemostat and Turbidostat?

Chemostat vs Turbidostat	
Chemostat is a type of continuous culture system in which the flow rate is constant and a single component of the culture medium controls the growth rate of the culture.	**Turbidostat** is another type of continuous culture system in which the flow rate does not remain constant and specific growth rate controls internally by culture reactions.
Photometer	
Does not need a photometer	Needs a photometer to measure turbidity
Specific Growth Rate	
A single component of the medium controls the specific growth rate externally	Measuring the optical density of the culture biomass controls the specific growth rate internally
Dilution Rate	
Dilution rate is constant	Dilution rate varies
Operates Bets at	
Operates best at a low dilution rate	Operates best at a high dilution rate
Control of the Growth Rate by a Single Nutrient Supply	
Supply of a single nutrient controls the growth rate of the microbe	Supply of a single nutrient does not control the growth rate of the microbes
Measuring Optical Density	
Does not need to measure optical density	Needs to measure optical density
Flow Rate	
Flow rate is constant	Flow rate does not remain constant