Introduction to USP – What is a Bioreactor?

Your Objectives:

At the end of the lesson, you should be able to distinguish different types of bioreactors.

The Bioreactor vessel

A **large-scale bioreactor** is a closed mechanical system designed to contain and grow genetically engineered cells at large-scale commercial volumes. A bioreactor is built according to strict sanitary guidelines and is designed to control all culture parameters critical to cell growth.

A **stirred tank bioreactor** will typically be cylindrical with a curved base. Its curved base assists in the mixing of vessel contents.

The bioreactor vessel itself is a double-walled, glycol-jacketed, sanitary pressure vessel designed to provide primary containment for the cell culture.

The bioreactor **vessel wall** consists of four layers:

Interior wall

The interior wall provides the sterile contact surface for the cell culture and is made of stainless steel. It is electropolished to produce a smooth, cleanable **finish***. Electropolishing is an electrochemical method of smoothing, deburring, polishing and cleaning stainless steel. This process also improves resistance to corrosion.

***** A 'finish' is a particular surface texture (e.g. on wood, metals, or other materials) designed to give a desired condition.

Glycol jacket

The glycol jacket is a heat-transfer surface welded to the outside of the interior wall. The jacket serves as a heat exchanger to regulate the cell culture temperature inside the bioreactor vessel.

Glycol jackets can be one of two types:

- dimpled
- half-pipe

Glycol is basically pumped into the base of the jacket and exits through the top. This flow path is designed to eliminate air pockets that might decrease the efficiency of the heat transfer.

Insulation

Located between the glycol jacket and the outer sheath is a layer of fire-retardant insulation that reduces heat loss of the bioreactor vessel.

Outer sheath

The outer sheath is the visible layer of the bioreactor. It envelops both insulation and glycol jacket. In contrast to the mechanically polished and electropolished interior wall, the surface of the outer sheath is finished by mechanical polishing only. The outer sheath is not part of any sterile operation, though.

Watch this useful YouTube video on fermentation processing:
https://youtu.be/5eKdZ0dVCCo?t=144

Principle types of bioreactor

Stationary bioreactors (i.e. where cell cultures are not agitated)

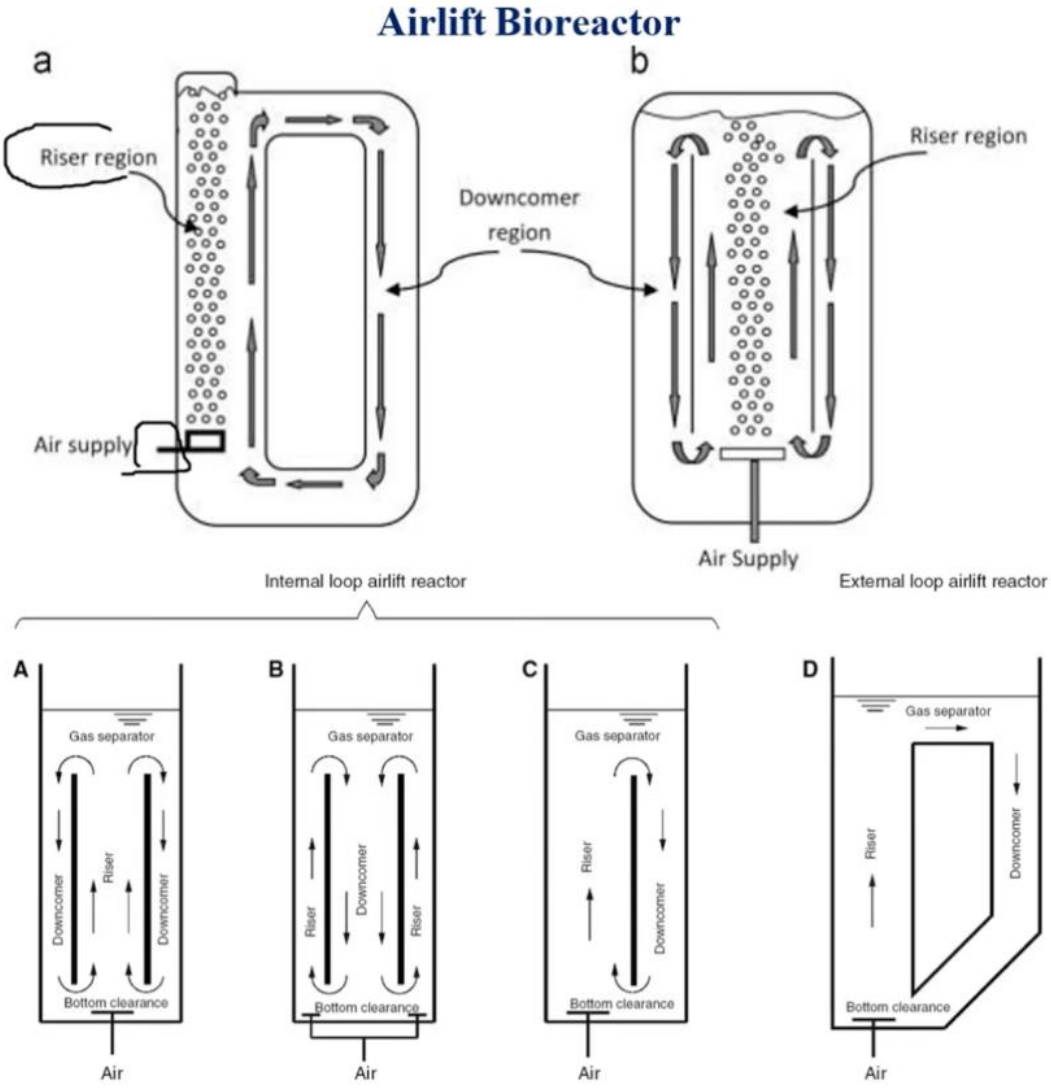
- T-flasks, 6-well plates, microtitre plates, roller bottles, shake flasks (etc.)

Mechanically agitated bioreactors

- Stirred tank bioreactors**,** spinner flasks, Wave bioreactors

Gas agitated bioreactors

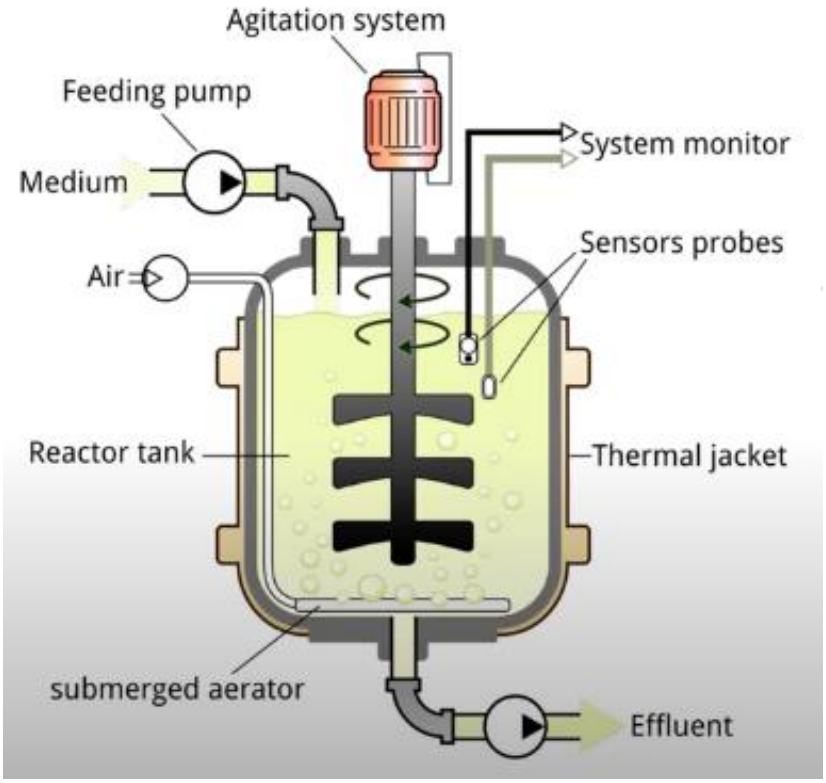
- Airlift reactors*****



***** An ALR, or airlift reactor, is a pneumatically-driven bioreactor especially suitable for large-scale culture of immobilized plant cells.

Fluid agitated bioreactors (stirred-tank)

- Fixed bed bioreactors, fluidized-bed bioreactors



Membrane bioreactors

- Hollow fibre reactors, Transwells®

Modes of operation of a bioreactor

- This is different to other types of bioreactors
- The four (4) different modes of operation are:
    - Batch
    - Fed-batch
    - Continuous
    - Perfusion
- All types of bioreactors can be operated in any of the four modes of operation.
- The modes of operation are determined by whether, and how, a medium is supplied to the culture.