

FDE 328

INDUSTRIAL MICROBIOLOGY

Instructor:

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Manufacturing Process in Bioprocesses

- ▶ The **bioreactor** is the heart of any biochemical process as it provides a meticulous environment for microorganisms to achieve optimal growth and produce metabolites.
- ▶ Bioreactors are capable of maintaining the desired biological activity by controlling the temperature, pH, O₂, nutrient supply, osmotic pressure and metal ions.
- ▶ Bioreactors are used in all domains of large-scale industrial biotechnology where a large scale production is required.
- ▶ The success of bioprocesses is dependent on;
 - to what extent the conditions can be controlled,
 - to what extent the optimum values can be kept constant,
 - to what extent the conditions can be optimized.

Manufacturing Process in Bioprocesses

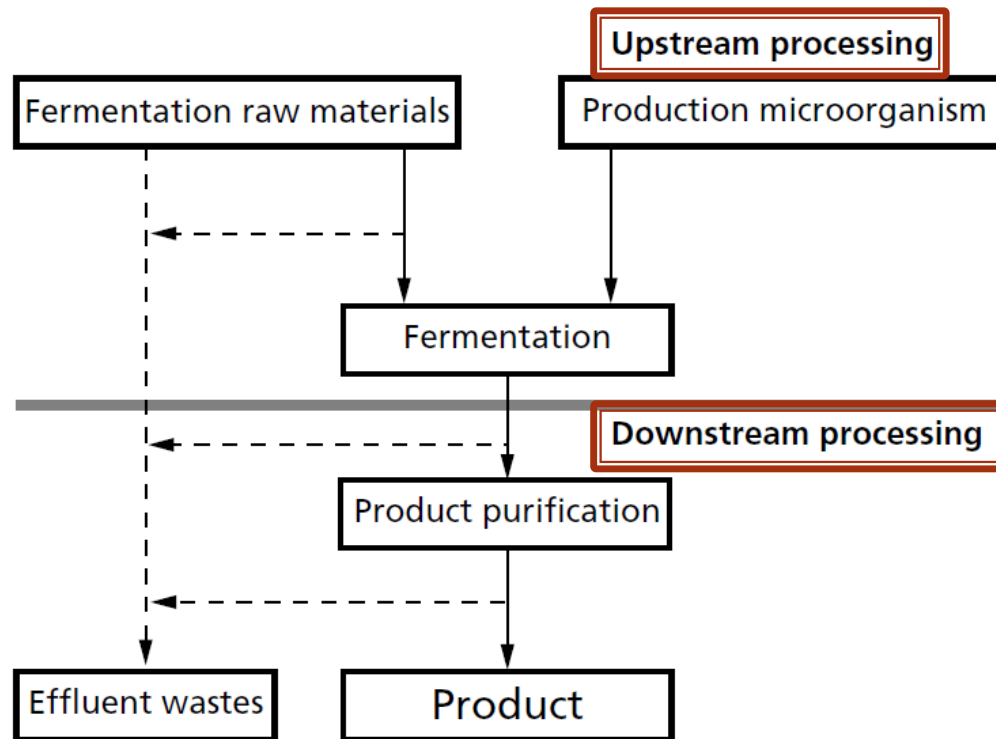
- ▶ Generally, a single kind of microorganism is selected for use in industrial productions.
- ▶ Pure culture (culture containing a single species of organism) is generally used rather than mixed culture (containing more than one species).
- ▶ All media and working area should be sterile in these processes.
- ▶ For most fermentations the air or oxygen supply is filter sterilized prior to being injected into the fermenter.

What products or services can be obtained from microorganisms?

(Important Industrial Processes)

1. **Production of microbial biomass** (microbial protein or single cell protein)
2. **Production of cell components** (enzyme or nucleic acid production)
3. **Production of metabolites** (These are chemical compounds such as ethyl alcohol, organic acids, antibiotics, vitamins which are produced as result of metabolic activity of cells.)
4. **Waste water treatment, leaching of metals** (e.g. Copper, iron, uranium and zinc) from low-grade mineral ores and wastes

Outline of a fermentation process



Outline of a fermentation process

- ▶ A typical operation involves;
 - Upstream processing (USP)
 - Downstream processing (DSP)

Fermentation process-Upstream Processing (USP)

- ▶ The USP is associated with all factors and processes leading to and including the fermentation.
- ▶ It consists of three main areas.
 1. The producer microorganism-fermentation microorganism
 2. The fermentation medium
 3. The fermentation

Fermentation process-Upstream Processing (USP)

1. The producer microorganism-fermentation microorganism

Key factors:

- obtain a suitable industrial microorganism to produce desired products
- improve strains to enhance productivity and yield
- maintain purity of cultures

Fermentation process-Upstream Processing (USP)

2. The fermentation medium

- ▶ The selection of suitable cost-effective carbon and energy sources, and other essential nutrients, along with overall media optimization are vital aspects of process development to ensure maximization of yield and profit.
- ▶ In many instances, the basis of industrial media are waste products from other industrial processes, notably sugar processing wastes, lignocellulosic wastes, cheese whey and corn steep liquor.

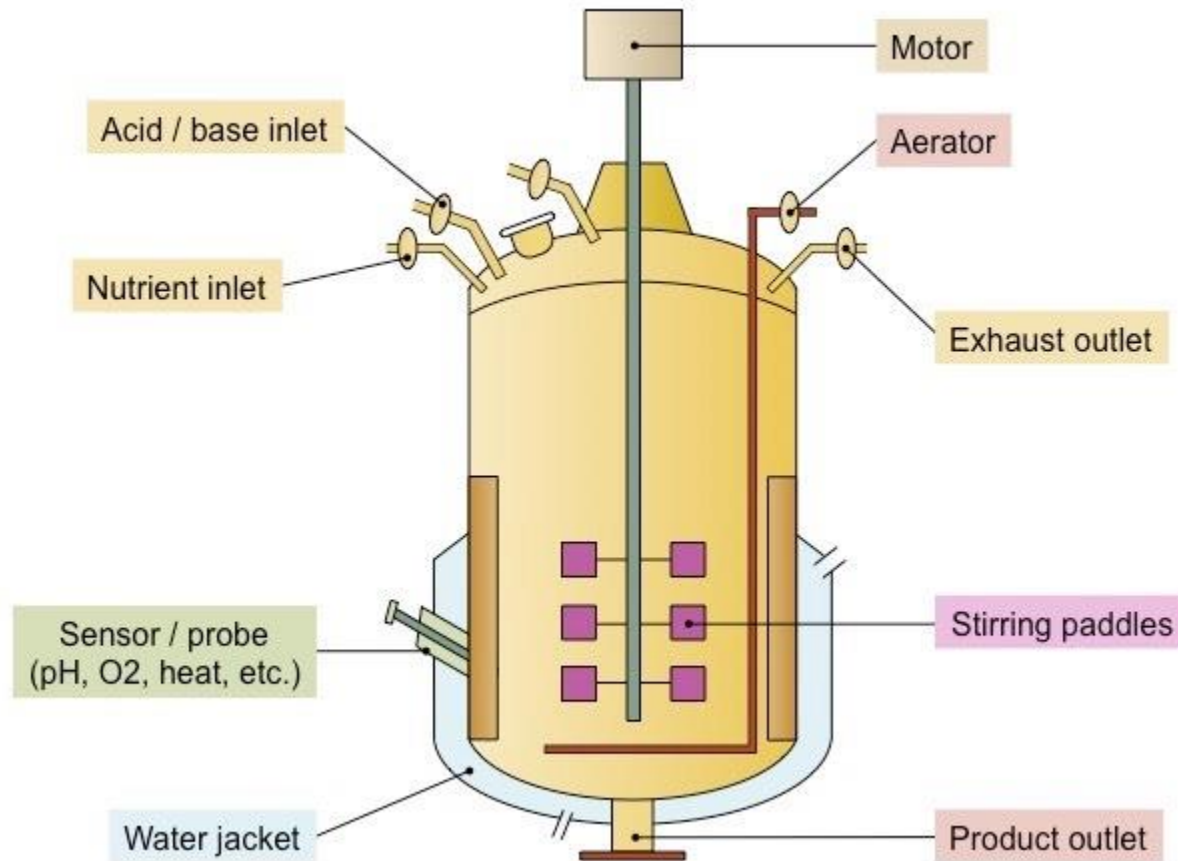
Fermentation process-Upstream Processing (USP)

3. The fermentation

- ▶ Industrial microorganisms are normally cultivated under rigorously controlled conditions developed to optimize the growth of the organism or production of a target microbial product.
- ▶ The synthesis of microbial metabolites is usually tightly regulated by the microbial cell. Consequently, in order to obtain high yields, the environmental conditions that trigger regulatory mechanisms, particularly repression and feedback inhibition, must be avoided.

Fermenters

The vessel in which fermentation is carried out is called **fermenter**.



Fermentation process-Downstream Processing (DSP)

- ▶ includes all unit processes following fermentation
- ▶ involve cell harvesting, cell disruption, product purification from cell extracts or the growth medium, and finishing steps
- ▶ must employ rapid and efficient methods for the purification of the product, while maintaining it in a stable form
- ▶ must be safe and inexpensive disposal of all waste products generated during the process