

## **Objectives**

The module will help the learners to develop an understanding of upstream processing.

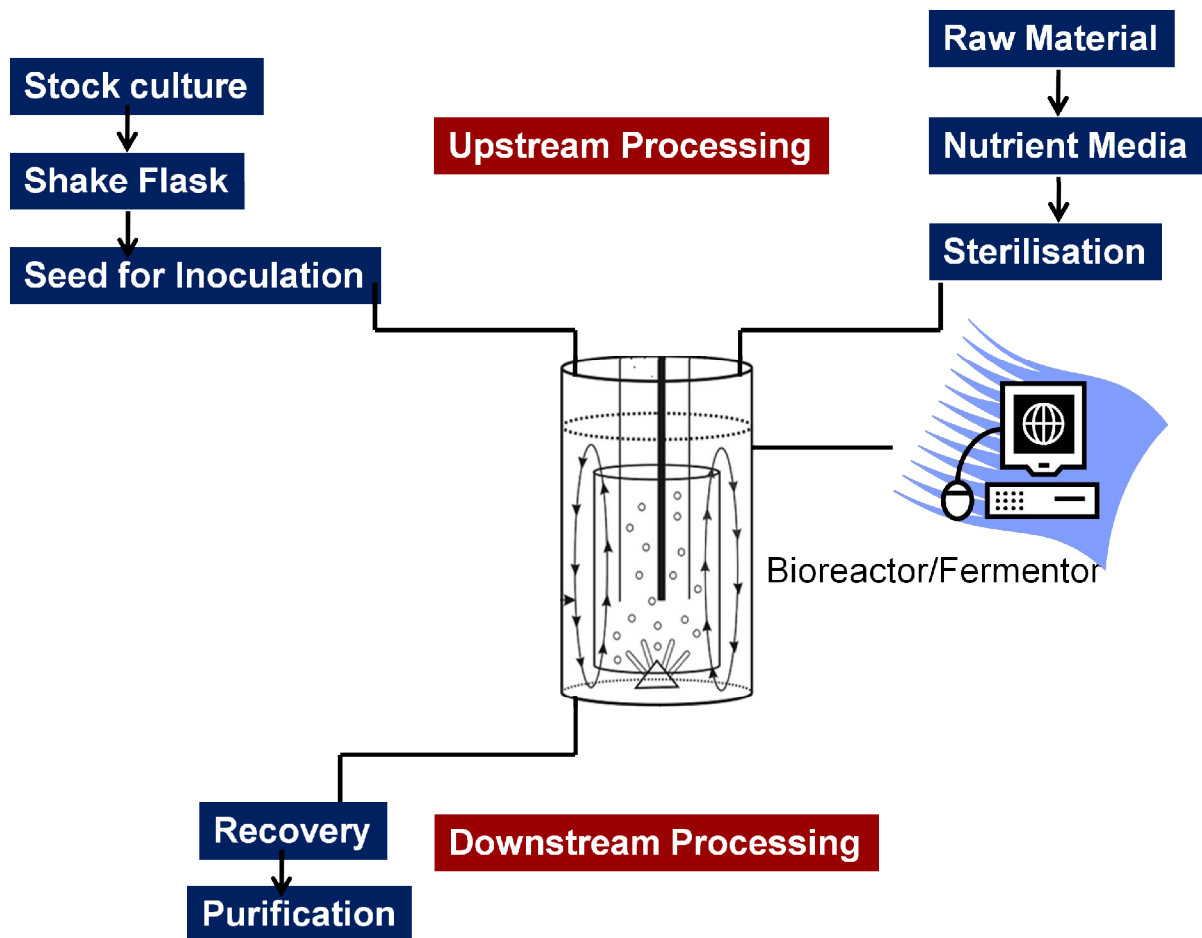
## **Learning Points**

- Biological process
- Cell culture
- Basic requirements for Bioprocess
- Applications of Bioprocess Engineering

## Biological process

Biological processes are to use living cells or their components to effect desired physical or chemical changes. It is to cultivate, grow and maintain prokaryotic or eukaryotic cells in large quantities in the cell culture and enable the biotechnological production of only the desired products such as antibiotics, vaccines and enzymes etc. and its recovery.

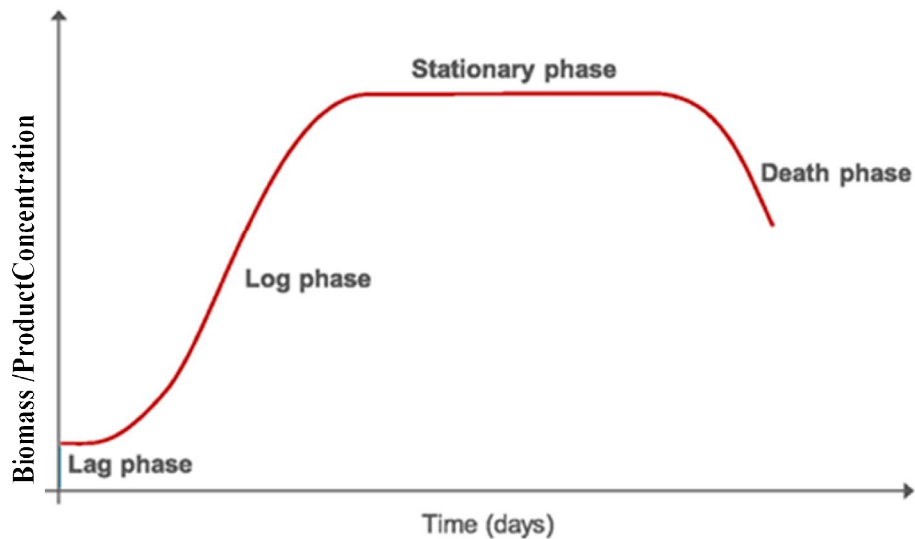
**Upstream processing** is related to the scale up of the production of biomass or the desired product of living cell in the artificial culture.



**Downstream processing** is related to the recovery of the product from the cell culture or biomass

## Principle of Upstream Processing:

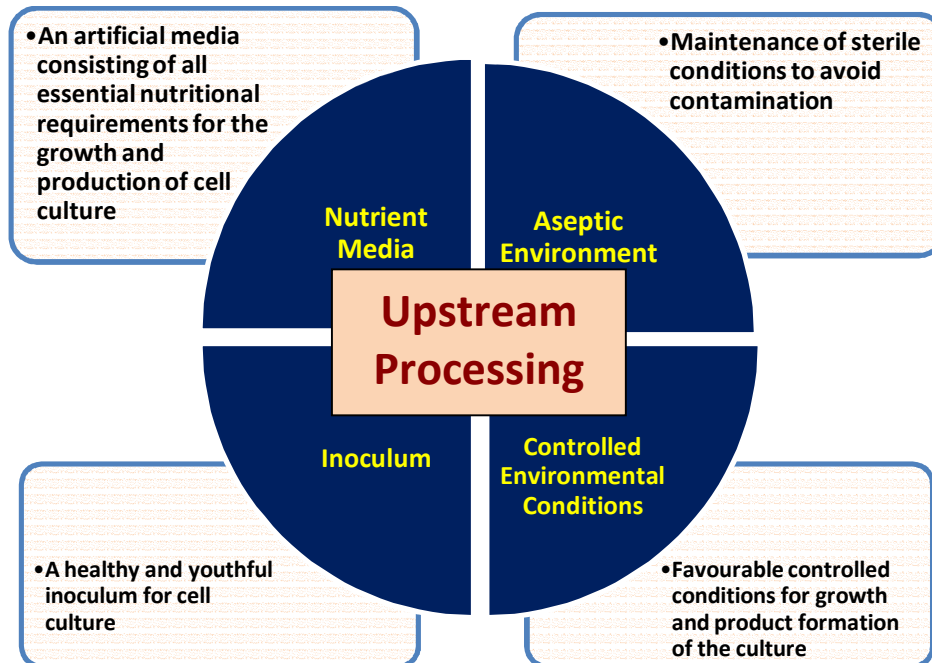
In Biological processes, when cells are inoculated for cultivation in an artificial medium in a closed culture system (Batch culture) *i.e.*, it contains only initial limited amount of nutrients, it undergoes different phases of growth cycle.



<b>Lag Phase</b>	<b>Cells adapt to the new environment Very little or no growth is going to take place.</b>
<b>Log Phase</b>	<b>Cells grow very fast and reaches to exponential</b>
<b>Stationary Phase</b>	<b>When growth slows down and becomes stationary with the limited supply of nutrients</b>
<b>Declining Phase or Death Phase</b>	<b>When the growth of cells ceases due to nonavailability of the nutrients leads to the death of many cells</b>

The product is harvested at one of the phases when its production is highest.

## Basic Requirements of Bioprocess (Upstream Processing):



## Cell culture:

<b>Microbial cell culture</b>	<b>Involves the cultivation of microorganisms such as; bacteria, blue-green algae, fungi, algae, protozoa etc.</b>
<b>Plant Cell culture</b>	<b>Involves the cultivation of cells or cell aggregates of plant cell</b>
<b>Animal Cell Culture</b>	<b>Involves the cultivation of cells or cell aggregates of animal cell</b>

## **Industrial Applications of Upstream Processing:**

Downstream Bioprocessing is useful in purification and recovery of biosynthetic products

The components which are salvaged from waste are recycled through downstream processing

Proper waste disposal and treatment

## **Assessment Questions:**

What is a biological process?

What are the basic requirements for upstream processing?