



Continuous and Batch Culture

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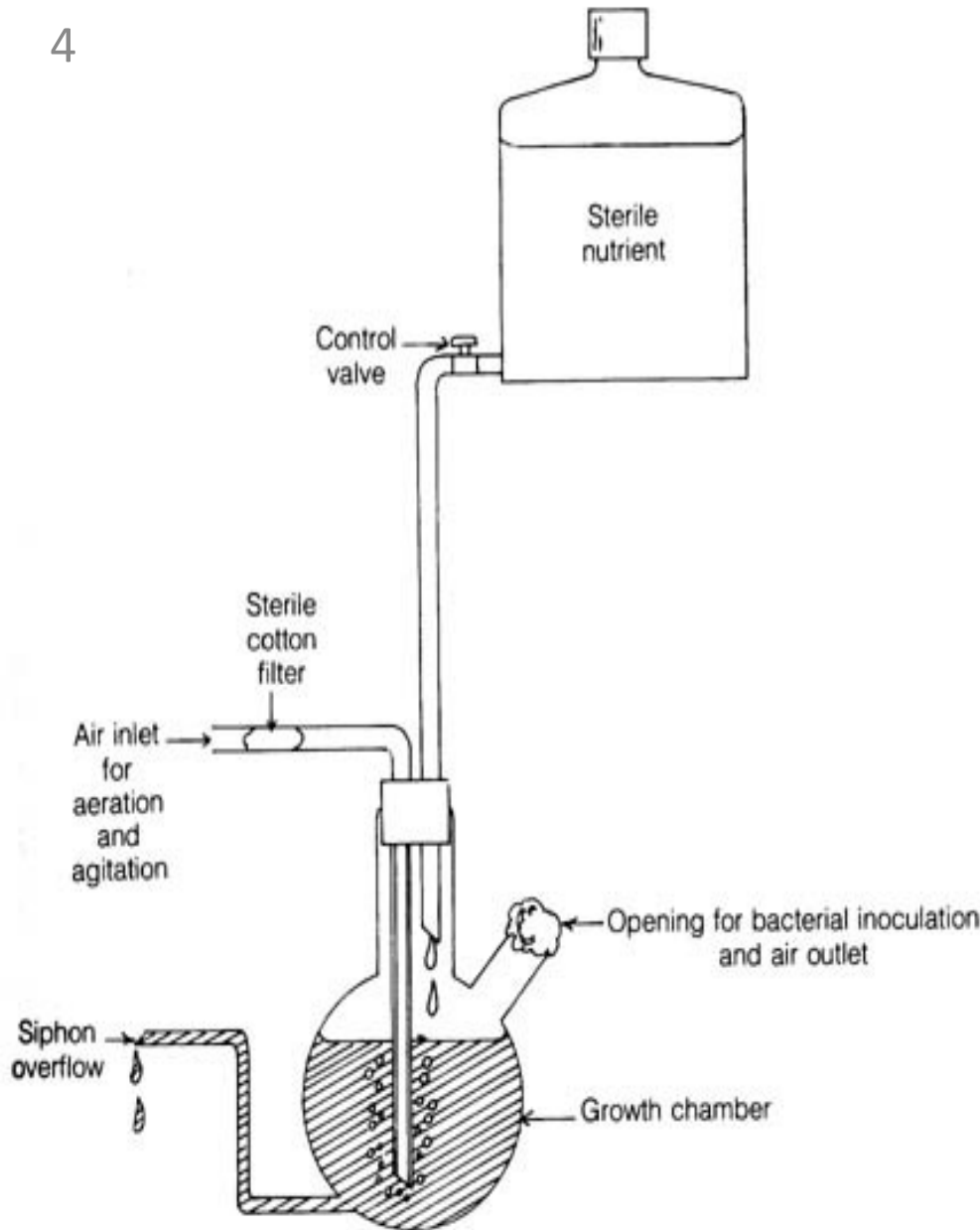
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Continuous Cultures

- **Continuous culture** is to keep a culture growing indefinitely. This can be done if:
 - fresh nutrients are continually supplied
 - accumulated cells and waste products are removed at the same rate
 - conditions such as temperature and pH are kept at their optimum values

- Continuous culture is important in industrial processes that harvest the **primary metabolites** of micro-organisms as their products. (Primary metabolites are produced in greatest quantities when the organisms are growing at their fastest rate).
- A culture vessel designed for continuous culture is called a **chemostat**:
- A chemostat has a fixed volume and flow rate, and thus a fixed dilution rate.

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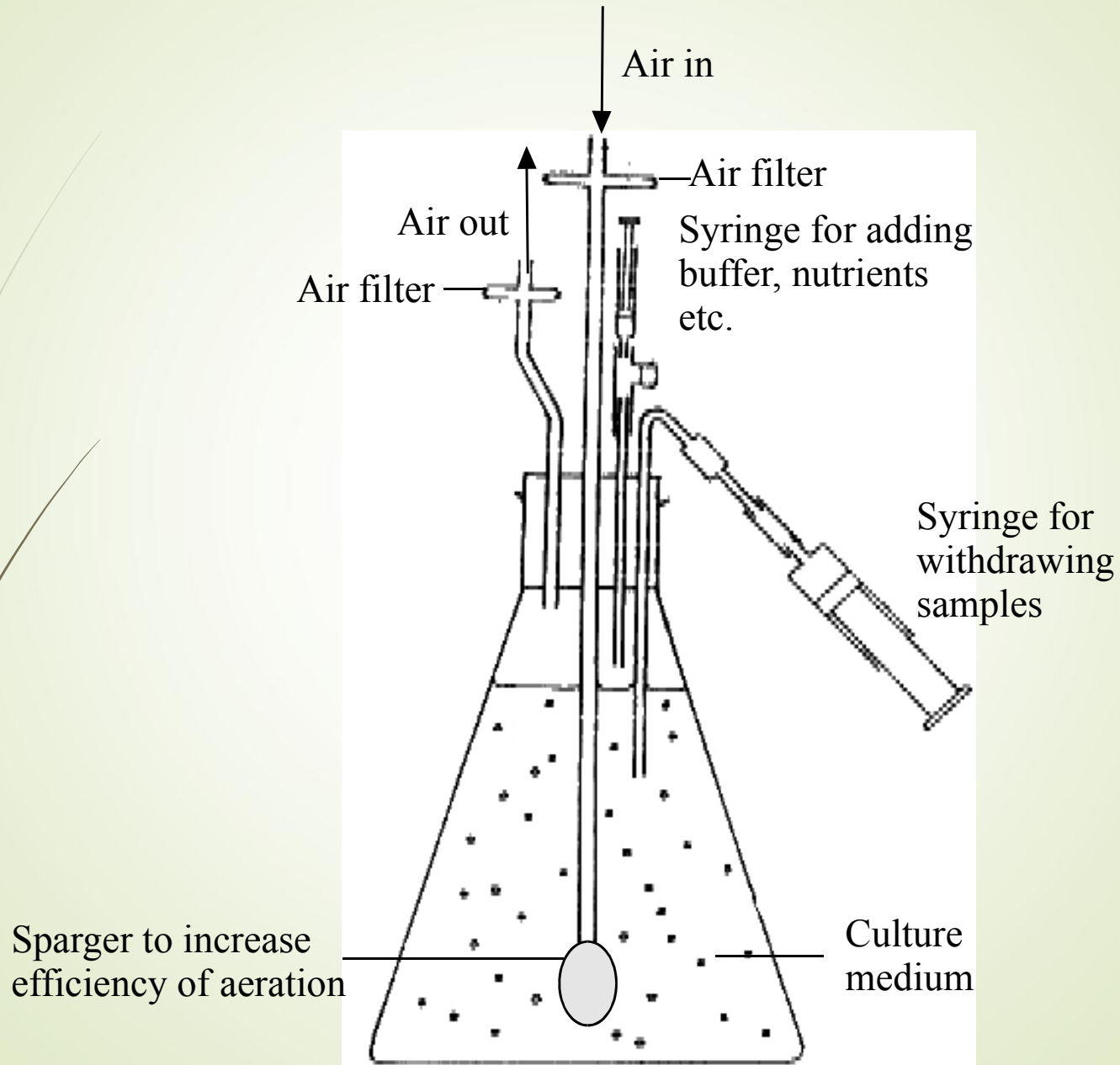
In addition to the features shown, the culture vessel would probably be fitted with temperature and pH probes for monitoring growth conditions.

Continuous culture contd..

- Another device called **turbidostat** is also used in this method.
- A **turbidostat** is a continuous microbiological culture device, similar to a chemostat or an auxostat which has feedback between the turbidity of the culture vessel and the dilution rate.
- A turbidostat dynamically adjusts the flow rate (and therefore the dilution rate) to make the turbidity constant.
- At equilibrium, operation of both the chemostat and turbidostat are identical.

Batch Cultures

- In **batch culture**: it is ready to be inoculated with a culture of micro-organisms, which will multiply, changing the conditions in the medium by using up the nutrients and producing their own waste products.



- Eventually conditions in the culture will become too unfavourable for the organisms to survive, and the population will die out.
- Batch culture is suitable for most school-based experiments on microbial growth, and is used industrially in many processes that harvest the **secondary metabolites** of micro-organisms (such as antibiotics).

- Secondary metabolites are produced by metabolic processes which are not essential to the organism's short-term survival, and are often not produced in large amounts when the organism is growing at its fastest.
- Industrial production is therefore most efficient if the organisms are allowed to reach maximum population size and stop growing before the product is harvested.

ASSESSMENT OF GROWTH

□ After inoculation the growth is as follows:

1. Lag phase
2. Accelerated growth phase
3. Exponential growth phase
4. Decelerated growth phase
5. Stationary phase
6. Death phase

LAG PHASE

- Lag Phase is an initial period of cultivation during which the change of cell number is zero or negligible.
- Even though the cell number does not increase, the cells may grow in size during this period.
- The Lag phase results from several factors:
 - When cells are placed in the fresh medium, the intracellular concentrations of cofactors, amino acids, ions will decrease and these have to be synthesized / transported first before cell division to occur.

LAG PHASE CONTD...

- When the cells are inoculated into medium containing different carbon source then the enzymes for its metabolism have to be transported.
- When cell are placed in medium containing several carbon sources then several lag phases may result. This is known as diauxic growth.
- When glucose and lactose are present then glucose will be utilized first then lactose. Presence of glucose will have catabolite repression on galactosidase enzyme which is required for lactose utilization.

ACCELERATED GROWTH PHASE

- At the end of Lag phase, when growth begins the division rate increase gradually and reaches a maximum value.
- Growth rate increases to maximum in this phase.

EXPONENTIAL GROWTH PHASE

- Cell division occurs in this phase.
- Often cell dry weight is used for cell concentration. During exponential phase we write as

$$\frac{dX}{dt} = \mu X$$

where μ - Specific growth rate

X- cell dry weight

OTHER PHASES

- The end of the exponential phase occur when any of the essential nutrients is depleted or toxic metabolite accumulated in the system. During this phase the growth rate declines.
- Stationary phase will follow this phase. The length of stationary phase may vary with cell type, previous growth conditions etc., In certain cases the product formation will occur during this phase
- Following this is the death phase where the cells will start to lyse and the cell density decreases.

Advantages of batch culture

- The culture is easy to set up
- The environmental conditions are relatively easy to control
- The types of vessels used can be used for different processes at different times
- If the culture becomes contaminated, it is only one batch that is lost
- The level of nutrients drops, which can create the conditions necessary for the microorganism to manufacture secondary metabolite such as penicillin

Advantages of continuous culture

- It can be carried out in smaller vessels (productivity high)
- The high productivity for biomass and intra- and extra-cellular enzymes is more cost effective

Disadvantages of continuous culture

- ▢ Microbial growth, clumping of cells and foaming tend to block up inlet pipes.
- ▢ Can be difficult to control all the environmental factors – could lead to considerable amount of waste.
- ▢ Not possible to create the low-nutrient, high-stress conditions under which secondary metabolites such as penicillin are produced.

Thank you!

