



# Basrah University

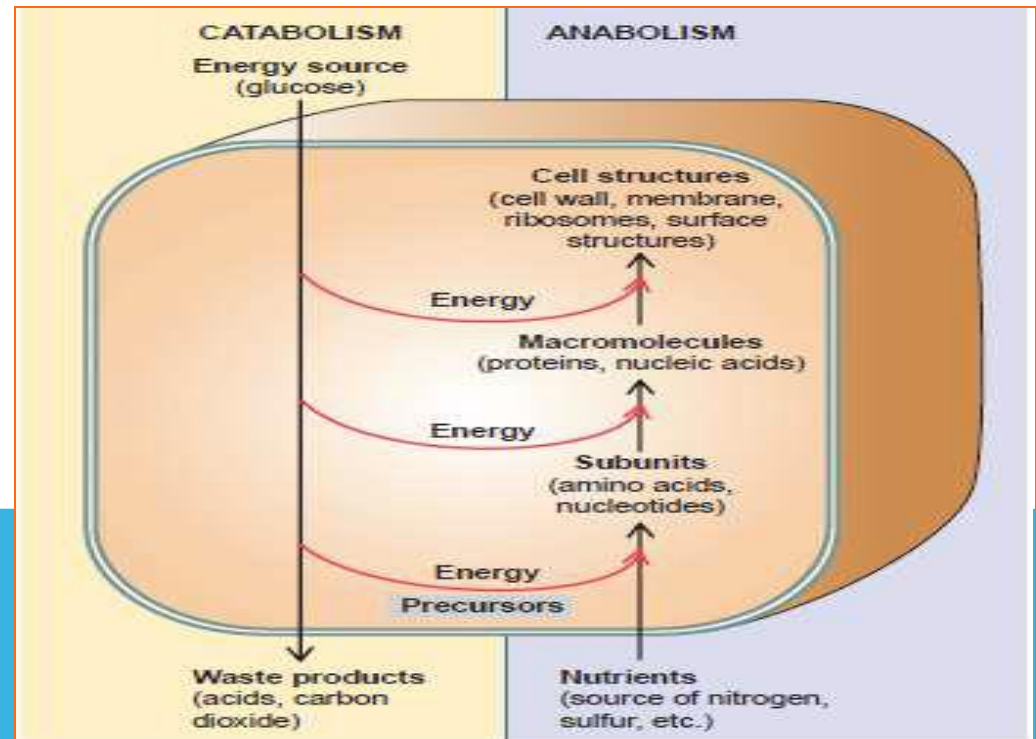
## Al-qurna Education College

### Biology Department: Postgraduate



## 2<sup>nd</sup> Course -Lecture # 3: Bacterial Growth

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# OBJECTIVES

1. To understand the basic concept of the bacterial growth
2. To explain the growth phases  
(Lag, Log, Stationary and Decline phases)

## Bacterial Growth

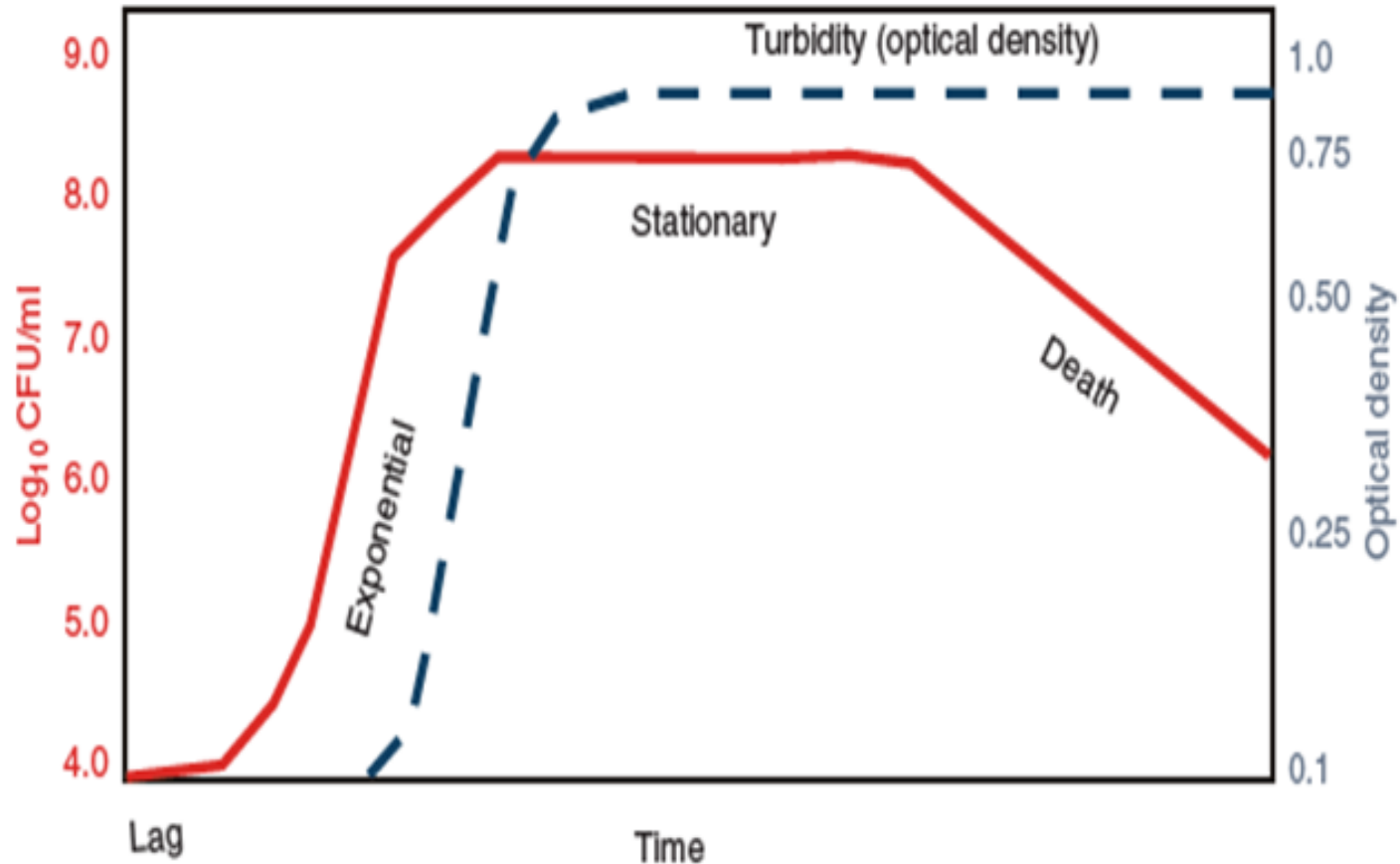
Bacterial growth is a complex process involving numerous anabolic (synthesis of cell constituents and metabolites) and catabolic (breakdown of cell constituents and metabolites) reactions. Ultimately, these biosynthetic reactions result in cell division.

There are two approaches to the study of growth under such controlled conditions: batch culture and continuous culture. In a batch culture the growth of a single organism, is evaluated using a defined medium to which a fixed amount of substrate (food) is added at the outset. In continuous culture there is a steady influx of growth medium and substrate such that the amount of available substrate remains the same.

# Growth In Pure Culture

## In A Flask

Typically, to understand and define the growth of a particular microbial isolate, cells are placed in a liquid medium in which the nutrients and environmental conditions are controlled. If the medium supplies all nutrients required for growth and environmental parameters are optimal, the increase in numbers or bacterial mass can be measured as a function of time to obtain a growth curve. Several distinct growth phases can be observed within a growth curve ( Fig. ). These include the lag phase, the exponential or log phase, the stationary phase, and the death phase. Each of these phases represents a distinct period of growth that is associated with typical physiological changes in the cell culture.



**FIGURE :** A typical growth curve for a bacterial population. Compare the difference in the shape of the curves in the death phase (colony-forming units versus optical density).

# 1. Lag Phase

- **When a microbial culture is inoculated into a fresh medium, growth usually begins only after a period of time called the lag phase**
- **The lag phase is defined to transition to the exponential phase after the initial population has doubled**
- **The lag phase is thought to be due to the physiological adaptation of the cell to the culture conditions. This may involve a time requirement for induction of specific messenger RNA (mRNA) and protein synthesis to meet new culture requirements. This interval may be brief or extended, depending on :**
  - a. **Type of bacteria.**
  - b. **Better the medium, shorter the lag phase.**
  - c. **The phase of culture from which inoculation is taken.**
  - d. **Size or volume of inoculum.**
  - e. **Environmental factors like temperature.**

## **2. LOG PHASE – LOGARITHMIC (EXPONENTIAL) PHASE**

**In logarithmic phase the bacterial cell start dividing and their number increase by geometric progression with time. During this period.**

- a. Cells in exponential growth are typically in their healthiest state .**
- b. Bacteria have high rate of metabolism**
- c. Bacteria are more sensitive to antibiotics and radiation .**
- d. Rates of exponential growth vary greatly. The rate of exponential growth is influenced by environmental conditions (temperature, composition of the culture medium), as well as by genetic characteristics of the organism itself.**

## **3. Stationary Phase**

**Although there is no net growth in stationary phase, cells still grow and divide. Growth is simply balanced by an equal number of cells dying. There are several reasons why a batch culture may reach stationary phase. One common reason is that the carbon and energy source or an essential nutrient becomes completely used up.**

**When a carbon source is used up it does not necessarily mean that all growth stops. This is because dying cells can lyse and provide a source of nutrients. Growth on dead cells is called endogenous metabolism . A second reason that stationary phase may be observed is that waste products build up to a point where they begin to inhibit cell growth or are toxic to cells**

**exponential growth is limited. It may be due to:**

- a. An essential nutrient of the culture medium is used up.**
- b. Accumulation of toxic products( a waste product) in the medium and sporulation may occur during this stage.**

## **4. Death Phase or Decline phase**

**If incubation continues after a population reaches the stationary phase, the cells may remain alive and continue to metabolize, but they will eventually die. When this occurs, the population enters the death phase of the growth cycle. In some cases death is accompanied by actual cell lysis. The factors responsible are:**

- a. Nutritional exhaustion , b. Toxic accumulation , c. Autolysin enzymes**



