**Microbial Growth:**

Refers to an increase in **cell number**, not in cell size.Bacteria grow and divide by **binary fission**, a rapid and relatively simple process.

**The stages of a typical growth curve (figure below) are:**

1. **Lag phase**: When the cells are adjusting to their new environment. During thisphase, cellular metabolism is accelerated, resulting in rapid biosynthesis ofcellular macromolecules, primarily enzymes, in preparation for the next phase ofthe cycle. Although the cells are increasing in size, there is no cell division andtherefore no increase in numbers.

2. **Logarithmic (log)/Exponential phase**: Under optimum nutritional and physical conditions, the physiologically robust cells reproduce at a uniform and rapid rate by binary fission. Thus there is a rapid exponential increase in population, which doubles regularly until a maximum number of cells is reached. The length of the log phase varies, depending on the organisms and the composition of the medium, although the average may be estimated to last 6 to 12 hours.

3. **Stationary phase**: During this stage occur:

-Population size begins to stabilize.

**-Number of cells produced = Number of cells dying**

-Overall cell number does not increase.

-Cell division begins to slow down.

-Factors that slow down microbial growth:

• Accumulation of toxic waste materials

• Acidic pH of media

• Limited nutrients

• Insufficient oxygen supply

4. **Decline or death phase**: Because of the continuing depletion of nutrients and buildup of metabolic wastes, occur the following

-Population size begins to decrease .

**Number of cells dying > Number of cells produced**

-Cell number decreases at a logarithmic rate.

-Cells lose their ability to divide.

-A few cells may remain alive for a long period of time.



**Generation Time:** Time required for a cell to divide, *and* its population to double.

Generation time varies considerably:

-*E. coli* divides every 20 minutes.

-Most bacteria divide every 1 to 3 hours.

-Some bacteria require over 24 hours to divide.

 **Measuring bacterial mass in liquid cultures of bacteria**

Common methods include:
a) turbidity (the cloudiness of a liquid culture of bacteria - a measure of total bacteria [live and dead] - This is usually quantitated with a spectrophotometer).
b) the number of viable bacteria in a culture - usually assessed by counting the number of colonies that grow after streaking a known volume on a plate ("plate counting" of colony forming units). In either case plotting the log of turbidity or number of living cells versus time is referred to as the growth curve. The generation time is defined as the time required for bacterial mass to double.