Bacterial Growth Phases

The Bacterial Growth:

Growth is the orderly increase in the sum of all the components of an organism. Cell multiplication is a consequence of growth, in unicellular organism, growth leads to an increase in the number of individuals making up a population. This process include replicate DNA , synthesis of new cell wall and plasma membrane and all cell components are double then cell division. This asexual process of reproduction is called **binary fission.**

Cell cycle: a group of steadily successive events are interrupted with periods which depending on environmental conditions. The required time from the beginning to the end of division known as generation time and the resulting growth called growth rate.

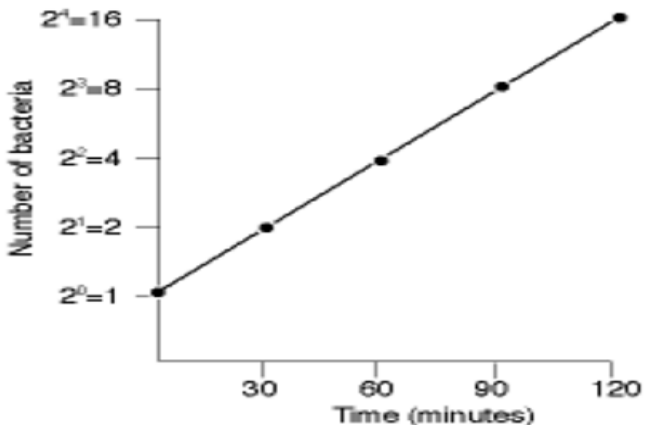
Generation time: The time required for a population of cells to double in number.

It takes short time in prokaryote (ex: 20-25 min in E coli). While in eukaryotes it takes two hours to several days.

Generation time varies with:

1- Species of M.O.
2- Nutrients.
3- Environmental conditions: PH, and temperature.
4- Growth phase.

The mathematics of bacterial growth is fairly simple, since each original cell divides to form two new cells, with the loss of the original parent. The mathematical series describing growth is: 1, 2, 4, 8, 16, … ., This can be written as 2^0, 2^1, 2^2, 2^3, 2^4, 2^5, ..



The bacterial growth can be measured by:

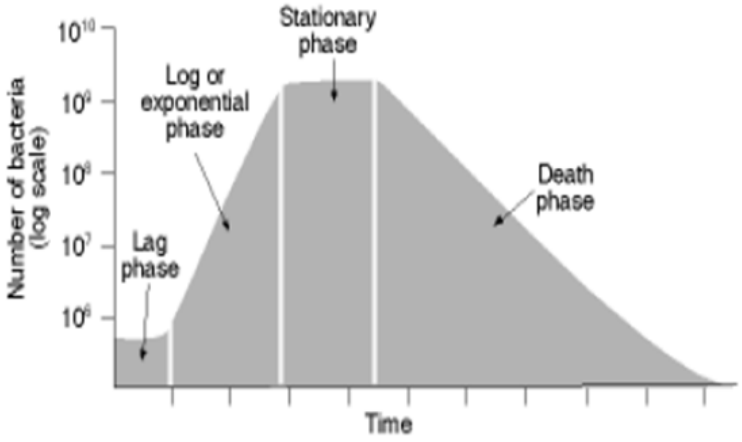
A: Cell concentration: viable cell count.

B: Bio mass density: by determining the dry weight of a microbial culture.

Growth curve of bacteria:

When bacteria are inoculated into a new culture media, it shows a characteristic growth curve . Bacterial growth over time can be graphed as cell number versus time. This is called a growth curve. This curve typically has four distinct phases :

1- **Lag phase:** represents the period of adaptation to the new environment.
   * Is the first phase.
   * No increase in cell number
   * Cells are actively metabolizing, in preparation for cell division.
   * It may be short or very long, according to the growth medium.
2- **Exponential or log phase:**
   * Is the second phase.
   * called the exponential or log phase.
   * This is the period in which the cells grow most rapidly, doubling at a fairly constant rate.
   * The generation time depends on several factors:
      1. The organism . 2. The growth medium 3. Temperature
3- **Stationary phase:** the exhaustion of nutrients or the accumulation of toxic products.
   * Is the third phase.
   * metabolism slows.
   * cells cease rapid cell division, due to :
   1- high cell density.
   2- depletion of nutrients .
   3- accumulation of waste products.
4- **Death phase:** after the period of time in the stationary phase and completely exhausted of nutrients and accumulation of high level of toxic substances, the death increase until it reach a steady level.
   * Is the final phase .
   * cells quickly lose the ability to divide.
   * exponential death.



Environmental growth factors

A- Nutrients :the following nutrients must be provided for any bacterial culture:

1. Hydrogen donors and accepters.
2. Carbon source.
3. Minerals elements (sulfur and phosphorus).
4. Growth factors (amino acid, pyrimidines and purin).

B- pH : the bacteria can be classified according to pH rang:

1. Neutrophiles: pH=6-8. most pathogenic bacteria.
2. Acidophiles: pH=3. can grow at pH as low as 3.
3. Alkaliphiles: pH=10.5. can grow at pH as high as 10.5.

C- Temperature: The bacteria can be classified according to temperature:

1. Mesophiles: grow best at 30-37°C. most pathogenic bacteria.
2. Psychophiles: grow best at15-20°C.
3. Thermophiles: grow best at 50-60°C.

D- Oxygen:

1. Obligate aerobes: need O_2 as hydrogen accepter.
2. Obligate anaerobes: need substance other than O_2 , and being sensitive to O_2 inhibition.
3. Facultative: able to live aerobically or an aerobically.

E- Salt and osmotic pressure:

1- Halophiles: requiring high salt concentrations (marine bacteria).
2- Osmophiles: requiring high osmotic pressure.