Microbial growth kinetics:

Growth: Is defined not in terms of cell size but as the increase in the number of cells, which occurs by cell division. Bacteria grow and divide by binary fission, a rapid and relatively simple process.

Requirements for microbial growth:

1-Physical requirements:

Which include the pH, temperature, Osmotic pressure, oxygen concentration, and Moisture content of the medium in which the organism is growing.

2-Chemical requirements:

Which include the amount of Carbon, nitrogen, Sulphur, phosphorous, and other trace elements provided in the growth medium.

During **batch and Continuous culture** fermentations the population of microorganisms goes through several distinct growth phases:

(a)Lag phase:

In which virtually no growth occurs and cells begin to synthesize inducible enzymes, vitamins or cofactors, etc.

(b) Logarithmic phase:

Once the cells have adapted to their new environment they enter the acceleration phase. Cell division occurs with increasing frequency until the growth rate for the specific

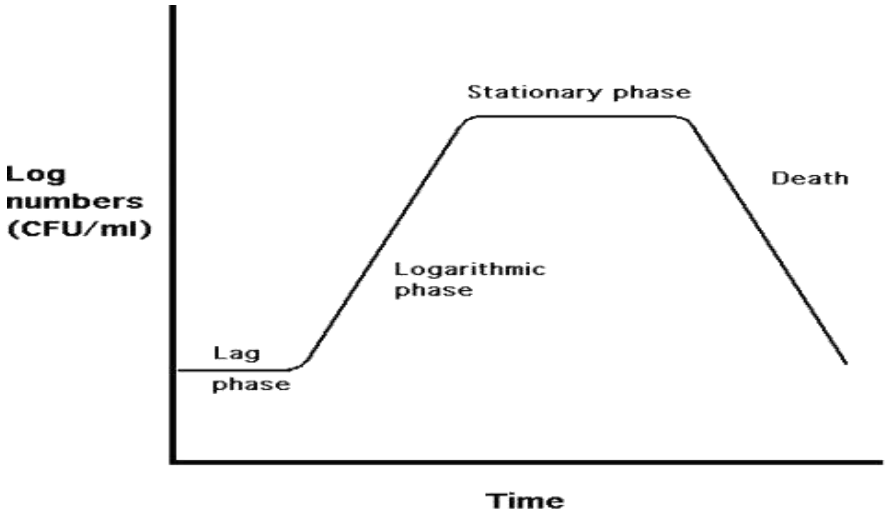
conditions of the fermentation is reached the maximum. At this point exponential growth begins and cell numbers/biomass increase at a constant rate. Mathematically, this exponential growth can be described by two methods; one is related to biomass and the other to cell numbers.

(c) Stationary phase:

Death rate is equal to rate of increase; during batch growth the microorganisms are continuously metabolizing the finite supply of nutrients available in the fermentation broth. After a certain time, the growth rate decreases and eventually stops. This cessation of growth can be due to depletion of essential nutrients or the build-up of toxic metabolites, while in continuous fermentations the exponential growth can be extended.

(d) Death phase:

Cells begin to die at a more rapid rate than that of reproduction



Hypothetical bacterial growth curve.

Microbial products:

1. ***Primary metabolites***:

   are essential for the growth and reproduction of microorganisms and it include amino acids, organic acids, vitamins and industrial solvents and they are produced during active growth in the log phase or trophophase of microbial reproduction.

2. ***Secondary metabolites***:

   are not essential for growth and reproduction and mainly include alkaloids and antibiotics they are produced in the idiophase or stationery phase of a batch culture after biomass production has peaked.

3. ***Microbial biomass***:

   (bacteria and fungi) is a measure of the mass of the living component of soil organic matter. The microbial biomass decomposes plant and animal residues and soil organic matter to release carbon dioxide and plant available nutrients.

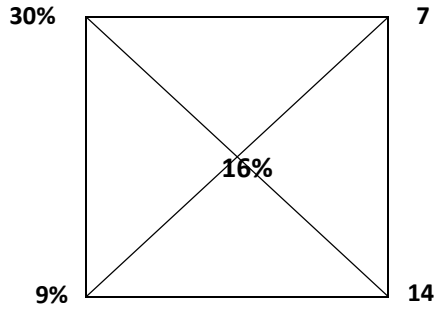
4. ***Recombinant products***:

   With the advent of gene cloning techniques, many industrially important genes from plants, animals and microbes have been cloned in a few selected microbes like *E.coli* and *Saccharomyces* and *Pichia*.

Preparation of Sugar and Salt Solutions:-

Sugar and salt solutions are used in industrial fermentation, we can calculate these solutions by a method known as ***person square method***, for example if we want to

prepare a sugar solution from two sugar with 30% and 9% to prepare a solution with 16%, we do the following:



$7+14=21$ Sum of parts.

$\frac{7\times100}{21}=33{,}33\,\text{ml}$ or from 30% sugar solution.

$\frac{14\times100}{21}=66{,}66\,\text{ml}$ or from 9% sugar solution