

Nutrition

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Nutrition: is a process by which organisms acquire chemical substances (Nutrients) used in cellular activities such as metabolism and growth. Organisms differ in the use of particular elements, their source and chemical form.

Microbial growth

Microbial growth refers to both the increase in cell size and number of cells in a population.

Cell division

Bacteria divided by binary fission; by 1- chromosomal duplication
2-synthesis of a new membrane and cell wall in the center of the cell form a septum that eventually divides the cytoplasm into two daughter cells, each contain a complete chromosome.

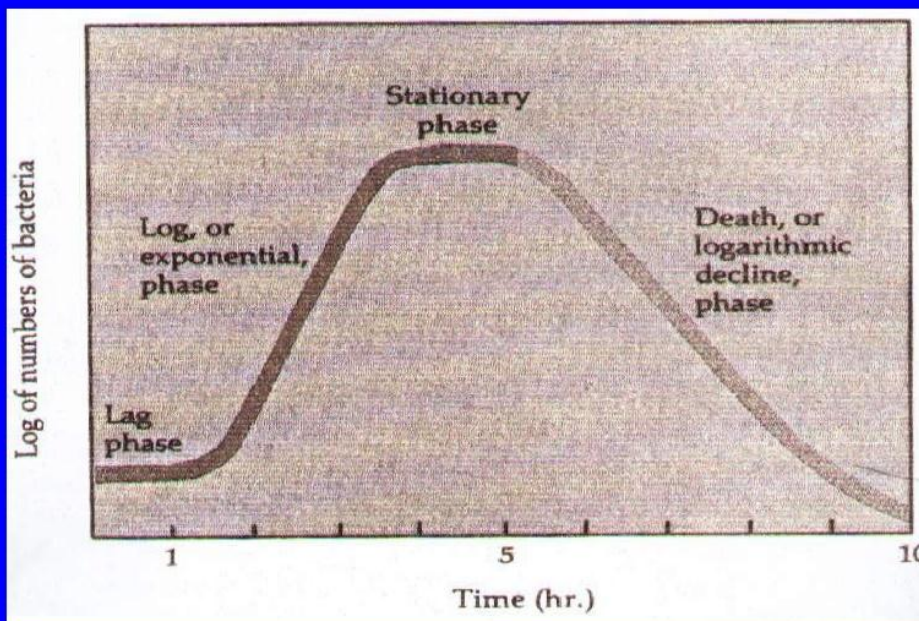
Generation or doubling time : The average generation time for bacteria is 30-60 minutes under optimum conditions. Most pathogens such as *Staphylococcus aureus* and *Escherichia coli*, double in 20– 30 minutes. The longest generation time requires days. E.g. *Mycobacterium leprae* that causes leprosy doubles in 20 to 30 days.

Bacterial Cell Count

- 1. Direct Count** – view under light microscope and count each cell - does not distinguish alive from dead
 - not very accurate but is very quick
- 2. Viable Plate Count**
 - counts only living bacteria
 - different dilutions of bacteria in a liquid culture are spread on agar plates, incubated over night and colonies counted

The growth curve is a graphic representation of closed population of bacteria overtime. This occurs in four phases, lag, log, stationary and decline phases.

1. The lag phase, Cells adjust to new environment. There is no change in the number of cells but metabolic activity is high leading to increase in cellular components.
2. The log or exponential phase:-,Bacteria multiply at the fastest rate possible under the conditions provided.- Are susceptible to cell wall active antibiotics - Form metabolic end products.
3. The stationary phase: there is an equilibrium between cell division and cell death caused by :decrease in nutrient, increase in cell population and accumulation of metabolic waste / end products e.g. antibiotics. Sporulating cells initiate spore formation
4. Death or Decline phase :The number of death cells exceeds the number of new cells formed due to lack of nutrients and accumulation of toxic waste.



Factors affecting bacterial growth

1-Nutritional requirements 2-Oxygen requirement 3- water 4- pH
5- Temperature 6- growth factors 7- Minerals.

- **growth factors:** are 1- Amino acids are required for protein synthesis
- 2- purines and pyrimidines requires for nucleic acids synthesis.

3- Vitamins needed as a coenzyme and functional groups of certain enzymes.

-Carbon Source :All bacteria require carbon for growth. Bacteria can be classified on the basis of their carbon source.–

Autotrophs: use carbon dioxide as the sole source of carbon–

Heterotrophs: use more complex organic compounds such as carbohydrates and amino acids as source of carbon–

Photoautotroph-energy need is supplied by light–

Chemoautotroph -energy is extracted from inorganic substances.

-Inorganic nutrients (ions):–Contain no carbon and hydrogen atoms
:phosphates, potassium, magnesium, nitrogen, sulfur, iron and numerous trace metals.

-Organic nutrients :contain carbon and hydrogen atoms. Include carbohydrates, lipids amino acids, Nucleic acids etc.

Carbohydrates :are used as the initial carbon source for many biosynthetic pathways and as electron donors(energy source) by many bacteria.

Phosphorus: is present as phosphates salts. They function in energy metabolism and as constituents of nucleic acids, phospholipids,teichoic acids, ATP, etc

Minerals: K, Mg, Ca, Fe are required in relatively high levels. Function as cofactors in enzyme reactions and as cations they act as buffers within the cells

Physical factors

1-Oxygen requirement Bacteria can be divided into **five** groups on the basis of their oxygen requirements•

1.Obligate or strict aerobes : The growth of bacteria is inhibited by absence of oxygen An example of a strict or obligate aerobe is *Pseudomonas aeruginosa*

2.Obligate anaerobes: Growth is inhibited by the presence of oxygen.

–Examples of obligate anaerobe are *Clostridium* spp and *Bacteriodes* spp

3.Facultative anaerobes are able to grow in the presence or absence of molecular oxygen. E.g. include staphylococci, streptococci, *Enterococci*, etc.

4. Microaerophilic bacteria: grow best under increased carbon dioxide tension. Examples include *Neisseria gonorrhoeae*, *Haemophilus influenzae*

5. Aerotolerant bacteria :can survive (but not grow) for a short period of time in the presence of atmospheric oxygen• Tolerance to oxygen is related to the

ability of the bacterium to detoxify superoxide and hydrogen peroxide produced as by products of aerobic respiration.

which converts hydrogen peroxide into water and oxygen is also present in all aerobic bacteria but is lacking in aerotolerant organisms. Strict anaerobes lack both enzymes

2-Temperature

There are three critical temperature ranges for growth:•(a) Minimum temperature-•(b). Maximum temperature:©. Optimum temperature:

Psychrophiles: Has optimum temperature below 15 C but capable of growth at 0 C

Mesophiles :-grow at a range of 20 –40 C. Include most bacterial pathogens with optimum temp. at 37C

Thermophiles :-microbes that has optimum temperature above45 C with a general range of 45-80 C Most thermophiles form spores e.g. *Bacillus stearothermophilus*

3-**Optimum pH** for most bacteria is near pH 7.0(pH 6.5- pH 7.5)Bacteria can be classified as alkaliphiles ,neutrophiles or acidophiles according to their degree of tolerance to pH changes

4-**Osmotic pressure:** When a microbial cell is in a hypertonic solution cellular water moves out of the cell through the cell membrane to the hypertonic solution. This osmotic loss of water causes shrinkage of the cell

PLASMOLYSISIn a hypotonic solution such as in distilled water, water will enter the cell and the cell may be lysed by such treatment (**PLASMOPTYSIS**). Halophiles require high salt concentrations for growth. Some bacteria can tolerate15% salt. E.g .*S. aureus*