

Growth & Development of bacteria

@VET GUIDE

Growth and nutrition of Bacteria

Growth indicates

- Qualitative
- Quantitative

The net effect an increase in total mass (biomass)

Divides by binary fission

The minimum nutritional requirements comprise of the source of C, N, H, O and some inorganic salts

On the basis of synthesizing capability

- **Autotrophs**: can synthesize their essential metabolites (organic compounds) from atmospheric CO_2 and N_2
 - derives energy from the sunlight called photoautotrophs
 - utilising inorganic compound for oxidation are called chemoautotrophs or chemolithotrophs
- **Heterotrophs**: can not synthesize.....but require performed organic compounds for growth eg. Majority of pathogenic bacteria

Growth requirements

A) nutritional req.

B) environmental conditions regulating growth

Nutritional requirements:

- 1) **Essential elements**: most important elements necessary for synthesis of bacterial structural components (Carbohydrate, lipid, protein, nucleic acid) are H, O, C, and N. in addition Ph, S,
- 2) **Mineral sources**: K, Ca, Mg, Fe, Cu, Co, Mn, Md, Zn,
- 3) **Organic growth factors**: some need which can't be synthesize by themselves called growth factors or bacterial vitamins require only in small amounts. Requirement of growth factor is variable

Growth requirements

Environmental factors affecting growth

1. Water:

- moisture is an essential requirement for bacteriological growth as 80% of bacterial cell consist of water.

2. Oxygen:

- Aerobes; obligatory and facultative
- Anaerobes: obligatory grow only in the absence of oxygen
- Aerotolerance –anaerobes: do not utilize oxygen but can survive
- Microaerophilic

3. Carbon dioxide : eg. *Brucella abortus* (5-10%) CO₂

Growth requirements

Environmental factors affecting growth

- 4. **Temperature:**
 - a) psychrophile: grows below 10°C eg. Soil and water saprophytes.
 - b) mesophile: between $20-40^{\circ}\text{C}$ (pathogenic bacteria)
 - c) thermophile: between 60 and 80°C eg *Bacillus sterothermophilus*

Environmental factors affecting growth

5. **pH**: Optimal pH (physiological pH) 7.2-7.4, however *Thiobacillus thiooxydans* (acidophills) grow at 3 pH, while *Cholera vibrios* and *Alkaligenes faecalis* (alkalophills) grow at 10.5 pH

6. **Light**: except phototrophic prefer to grow in darkness. Photochromogenic mycobacterium produce pigment when incubated in presence of light.

7. **Osmotic pressure**: able to withstand a wide range of ext. osmotic pressure because of mechanical strength of cell wall. NaCl (0.5%) in most of the medium.

8. **Symbiosis and antagonism**: symbiosis e.g. Staph helps H. influenza, antagonism e.g. *Pseudomonas aeruginosa* to *Gonococcus* and Anthrax bacilli.

Bacterial metabolism

- Although metabolic process of utilization of food stuff almost similar in bacterial cell and higher organisms, the former shows higher metabolic activity than later

- Metabolism:

Catabolism:

macromolecules to micro molecules, absorption into the cell, conversion into basic blocks including inter-conversion ADP to ATP.

breakdown of macromolecules in extra cellular environment into smaller subunits is carried out by various hydrolytic enzymes such as protease, polysaccharidase, lipase and enzyme involved in glycolytic pathway, pentose phosphate cycle and TCA cycle.

the breakdown products like aminoacids, fattyacids and simple sugars enter the bacterial cell either by passive diffusion or help by specific carriers and enzymes (permeases). Nutrients thus absorbed in to cell are used for synthesis of basic building blocks

Bacterial metabolism

Anabolism:

process by which the basic building blocks are utilised in the synthesis of various cellular structures such as monomers and polymers. Energy supply is necessary for anabolic reactions whereas catabolic reactions normally balance each other.

- Metabolic character of a bacterium depends on whether it is aerobic or anaerobic.
- Aerobic organism obtain their energy and intermediates only through oxidation and energy is provided ATP (oxydative phosphorylation).
- Anaerobic bacteria obtain their energy by fermentation (substratelevel phosphorylation)
- Facultative anaerobes may act in both ways.

Bacterial growth and division

- **Binary fission**
- Initiated when a bacterial cell reaches a critical mass in its cellular constituents and structures
- **Nuclear division precedes bacterial cell division.**
- Chromosomes replication initiated at the cytoplasmic membrane
- During replication, two strands of DNA separate and new complementary strands formed on each of the originals resulting in formation of two identical double stranded DNA molecules.
- Replicated DNA molecules distributed to the two daughter cells.