

# Bacterial Growth

Refers to an increase in bacterial cell numbers (multiplication), which results from a balanced increase in the mass of cellular constituents and structures of the bacteria

Generation time: time required for one cell to divide to two cells.

- may be determined by measuring cell concentration (viable cell counts or turbidity measurement) or biomass density (dry weight).

- usually occurs asynchronously (i.e., all cells do not divide at precisely the same amount).

## Requirements for bacterial growth

### 1. Nutritional requirements

- most bacteria of medical importance require carbon, nitrogen, water, inorganic salts and source of energy for growth. Some bacteria require special growth factors, including amino acids and vitamins.

- bacteria are classified into two main groups according to the type of compounds they can utilize as a carbon source:

#### Autotrophs:

- do not require preformed organic compound for growth. Most of which can use carbon dioxide as their carbon source.

#### Heterotrophs:

- require preformed organic compound (carbohydrates, amino acids) for growth.

- include most bacteria of medical importance.

### 2. Oxygen requirements

Bacteria may be classified into four groups according to their O<sub>2</sub> requirements:

#### • Obligate (strict) aerobe:

- grow only in the presence of O<sub>2</sub>. (*P. aeruginosa*)  
- contain the enzyme superoxide dismutase, which protects them from the toxic free radical (O<sup>-</sup><sub>2</sub>) by combining it with hydrogen ion to form hydrogen peroxide, which is subsequently degraded by peroxidase.

- Obligate (strict) anaerobe:
  - grow only in the absence of free O<sub>2</sub>. (*Clostridia*, *Bacteroids*)
  - comprise greater than 90% of the bacterial flora of the colon
- Facultative anaerobe:
  - grow in the presence or absence of O<sub>2</sub>.
  - include most pathogenic bacteria.
- Microaerophilic (aerotolerant anaerobe):
  - grow better in low O<sub>2</sub> concentrations. (*Campylobacter*)

### 3. **Temperature requirements**

Bacteria can be classified according to the optimal temperature for growth:

- Psychrophiles: low temperature (< 20°C; some below 0°C).
  - *L. monocytogenes*, a cause of food poisoning, will grow slowly at 4°C.
- Mesophiles: 20°C – 40°C
  - most medically important species are mesophiles and grow best at 37°C.
  - *N. gonorrhoeae*, restrict mesophiles (35°C - 37°C).
- Thermophiles: > 45°C.

### 4. **Correct pH**

- most pathogenic bacteria grow best in slightly alkaline pH (pH 7.2 – 7.4).
- *V. cholera* will grow better at alkaline pH (pH 8.0 – 8.4).
- *Lactobacillus* can grow in acidic environment (pH 3.0 – 4.0).

## **Bacterial growth curve**

- requires inoculation of bacteria into a liquid growth medium.
- has four main phases:

1. Lag phase : cells adapted to new environment.
2. Exponential (log) phase: cell biomass is synthesized at a constant rate.
  - balanced growth.
  - the length of the curve depend on mean generation time.
3. Stationary phase: cells exhaust essential nutrients or accumulate toxic products.
  - balanced growth ceases.
4. Decline (death) phase: cells may die due to toxic products.