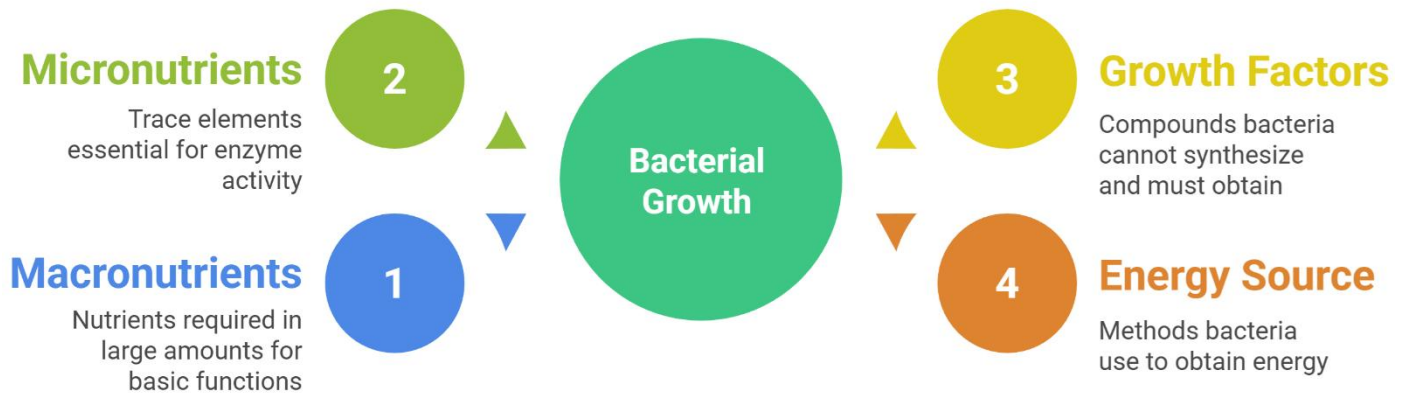


Bacteria

Nutritional Requirements of Bacteria

- Bacteria require a variety of nutrients for growth and reproduction.

These nutrients can be broadly classified into:



A. Macronutrients:

These are required in large amounts.

1. Carbon (C):

- Most essential element.
- Needed for cellular structures and energy.
- Can be derived from organic compounds (heterotrophs) or carbon dioxide (autotrophs).

2. Nitrogen (N):

- Important for proteins, nucleic acids, and other cellular components.
- Sources include ammonia (NH_3), nitrates (NO_3^-), or nitrogen gas (N_2 in nitrogen-fixing bacteria).

3. Hydrogen (H):

- Found in water and organic compounds.
- Necessary for redox reactions and organic compound formation.

4. Oxygen (O):

- Present in water and organic compounds.
- Acts as a terminal electron acceptor in aerobic respiration.

5. Phosphorus (P):

- Essential for ATP, nucleic acids, and phospholipids.
- Supplied as phosphate ions (PO_4^{3-}).

6. Sulfur (S):

- Found in amino acids like cysteine and methionine.
- Available as sulfate (SO_4^{2-}) or in organic sulfur sources.

7. Potassium (K), Magnesium (Mg), Calcium (Ca), and Iron (Fe):

- Required for enzyme function, membrane stability, and electron transport.

B. Micronutrients (Trace Elements):

- Required in minute amounts for enzyme activity.
- **Examples:** Zinc (Zn), Manganese (Mn), Cobalt (Co), Molybdenum (Mo), Copper (Cu), Nickel (Ni).

C. Growth Factors:

- Some bacteria cannot synthesize all compounds they need, so they must obtain these from the environment.
- **Examples:**
 - Vitamins (e.g., niacin, biotin)
 - Amino acids
 - Purines and pyrimidines

D. Energy Source:

- Bacteria can be classified based on how they obtain energy.
 - **Phototrophs:** Use light (e.g., Cyanobacteria).
 - **Chemotrophs:** Use chemical compounds.
 - **Chemoorganotrophs:** Use organic molecules.
 - **Chemolithotrophs:** Use inorganic substances (e.g., H_2S , NH_3).

Growth of Bacteria

Bacterial growth refers to **an increase in the number of cells**, not the size of individual cells.

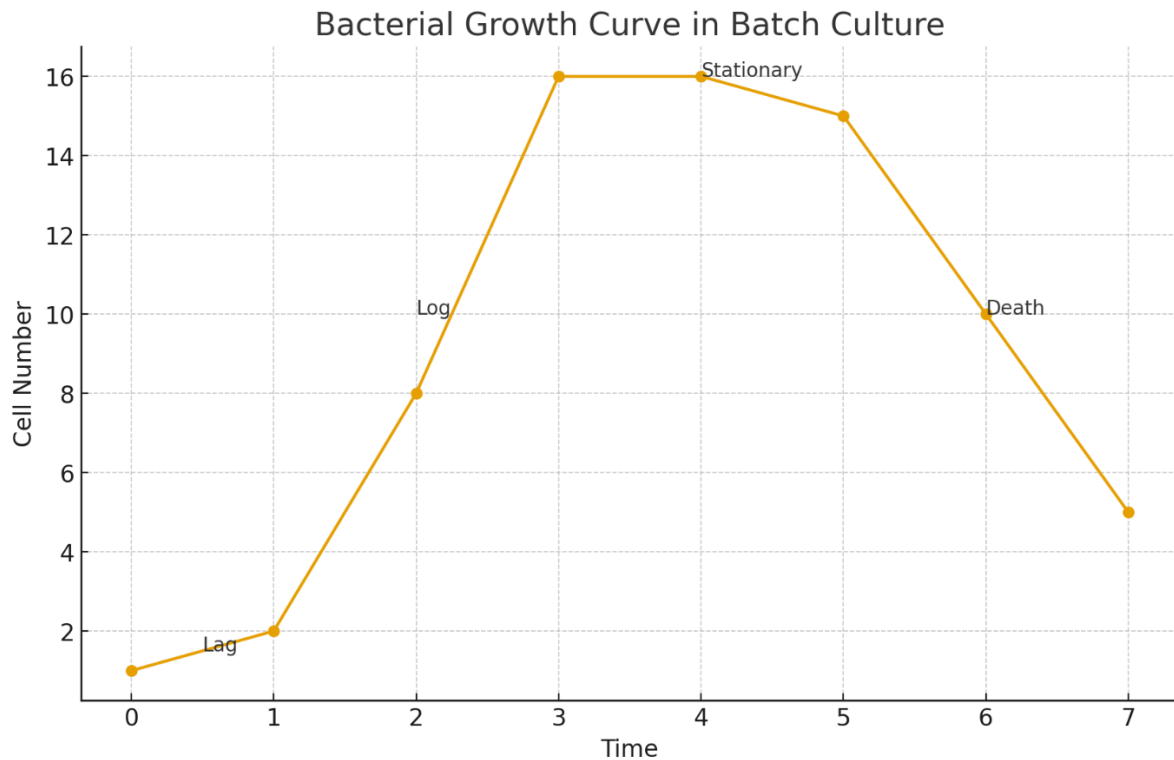
Binary Fission:

- Main mode of reproduction in bacteria.
- One cell divides into two identical daughter cells.
- **Steps:**
 1. DNA replication.
 2. Elongation of the cell.

3. Septum formation.
4. Cell separation.

Growth Curve (in Batch Culture):

Occurs in four phases when bacteria are cultured in a closed system:



A. Lag Phase:

- Adaptation period.
- Cells metabolically active but not dividing.
- Enzymes and proteins are synthesized.

B. Log (Exponential) Phase:

- Rapid cell division.
- Cells most metabolically active.
- Used for biochemical studies and antibiotic susceptibility tests.

C. Stationary Phase:

- Nutrient depletion and waste accumulation.
- Growth rate = death rate.
- Some cells form endospores (e.g., Bacillus, Clostridium).

D. Death (Decline) Phase:

- Cell death exceeds growth.
- Population declines.

Generation Time:

- Time taken for one cell to divide into two.
- Varies with species and conditions (e.g., *E. coli* ~20 minutes under optimal conditions).

Cultivation of Bacteria

Cultivating bacteria involves providing appropriate environmental conditions and nutrients for their growth.

Physical Conditions:

A. Temperature:

- Psychrophiles (0–20°C)
- Mesophiles (20–45°C)
- Thermophiles (45–80°C)
- Hyperthermophiles (>80°C)

B. pH:

- Most bacteria prefer pH 6.5–7.5.
- Acidophiles and alkaliphiles grow in extreme pH ranges.

C. Oxygen Requirements:

- **Obligate aerobes:** Need O₂.
- **Obligate anaerobes:** Killed by O₂.
- **Facultative anaerobes:** Grow with or without O₂.
- **Microaerophiles:** Require low O₂.
- **Aerotolerant anaerobes:** Do not use O₂ but can tolerate it.

D. Water and Osmotic Pressure:

- Bacteria need water.
- Halophiles grow in high salt concentrations.

Culture Media:

- Culture media are nutrient preparations used to grow bacteria in the lab.

Types of Media:

A. Based on consistency:

- Liquid (broth)

- Semi-solid
- Solid (with agar)

B. Based on purpose:

- **Basic (nutrient) media:** For general bacterial growth.
- **Enriched media:** Contains additional nutrients (e.g., blood agar).
- **Selective media:** Inhibits some organisms, allows others (e.g., MacConkey agar inhibits Gram-positives).
- **Differential media:** Shows visible differences (e.g., lactose fermenters on MacConkey agar).
- **Transport media:** Preserves specimens during transport.

Aseptic Techniques:

- Prevent contamination of cultures and environment.
- Includes sterilization, flame techniques, and use of sterile instruments.



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