''बेटी बचाओ, बेटी पढ़ाओ''

JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY, JAIPUR

(Format for Preparing E Notes)

Faculty of Education and Methodology

Faculty Name- **JV'n Shalini Devi Prajapati**

Program- **M.Sc. Microbiology First Semester**

Course Name - Biomolecules and Microbial Biochemistry

Session No. & Name – Nutritional requirement and growth characteristics of bacteria

Academic Day starts with –

- Greeting with saying 'Namaste' by joining Hands together following by 2-3 Minutes Happy session, Celebrating the birthday of any student of the respective class and the National Anthem

Lecture Starts with-

Topic to be discussed today- Today I will discuss about Nutritional requirement and growth characteristics of bacteria.

Lesson deliverance (ICT, Diagrams & Live Example)-

- PPT (8 Slides)
- Diagrams
- Tables

NUTRITIONAL REQUIREMENTS

Bacteria are prokaryotes & unicellular, they do not contain chlorophyll, & also do not show true branching.

The bacterial cells contains-

- Water (80%)
- Proteins
- Polysaccharides
- Lipids
- Nucleic acids
- Mucopeptides
- Low molecular weight compounds.

The minimum nutritional requirements of bacteria for growth are-

Bacteria can be classified based on their metabolic properties, which refer to how they obtain and utilize energy and carbon sources.

These metabolic classifications are broad categories that help describe how bacteria generate energy and synthesize essential molecules.

The primary metabolic classifications for bacteria include:

Sl. No.	HETEROPHILIC BACTERIA Heterotrophic bacteria obtain their carbon from organic compounds produced by other organisms. They are essentially "consumers" of organic matter	AEROBIC HETEROTROPHS • These bacteria require oxygen for their metabolic processes. Examples include most common bacteria found in soil and water. ANAEROBIC HETEROTROPHS

2. **Heterotrophic Bacteria**:
    - Heterotrophic bacteria obtain their carbon from organic compounds produced by other organisms. They are essentially "consumers" of organic matter.
    - They can be further categorized into:
        - **Aerobic Heterotrophs**: These bacteria require oxygen for their metabolic processes. Examples include most common bacteria found in soil and water.
        - **Anaerobic Heterotrophs**: These bacteria can thrive in environments devoid of oxygen. Some anaerobes are beneficial, such as those involved in fermentation, while others can be pathogenic.
3. **Autotrophic Bacteria**:
    - Autotrophic bacteria are capable of using inorganic sources of carbon (usually carbon dioxide) to synthesize their own organic compounds.
    - They can be further divided into:
        - **Photoautotrophs**: These bacteria use light energy to convert carbon dioxide into organic compounds through photosynthesis. Examples include cyanobacteria (blue-green algae) and purple sulfur bacteria.
        - **Chemoautotrophs**: These bacteria use energy obtained from chemical reactions (oxidation of inorganic compounds) to fix carbon dioxide. They are often found in extreme environments, such as hydrothermal vents, and play a crucial role in biogeochemical cycles. Examples include nitrifying bacteria and sulfur bacteria.
4. **Mixotrophic Bacteria**:
    - Mixotrophic bacteria have the capability to use both organic and inorganic carbon sources. They can switch between heterotrophic and autotrophic modes depending on environmental conditions.
5. **Lithotrophic Bacteria**:
    - Lithotrophic bacteria are a subset of autotrophic bacteria that use inorganic compounds as their source of electrons for energy, often in the absence of organic carbon sources.
    - Examples include nitrifying bacteria, which convert ammonia to nitrate, and sulfur-oxidizing bacteria.

6. **Organotrophic Bacteria**:
    - Organotrophic bacteria obtain energy from the oxidation of organic compounds. They can be further categorized based on their use of oxygen:
        - **Aerobic Organotrophs**: These bacteria require oxygen for their metabolism.
        - **Anaerobic Organotrophs**: These bacteria can thrive in environments without oxygen.

These metabolic classifications provide insights into how bacteria survive and thrive in various environments and niches. Bacteria often exhibit metabolic diversity and their specific metabolic pathways can be further classified and studied based on the types of compounds they utilize and produce.

PHYSICAL PARAMETERS FOR GROWTH

Microorganisms require specific physical parameters for optimal growth and reproduction.

The key physical parameters for growth include:

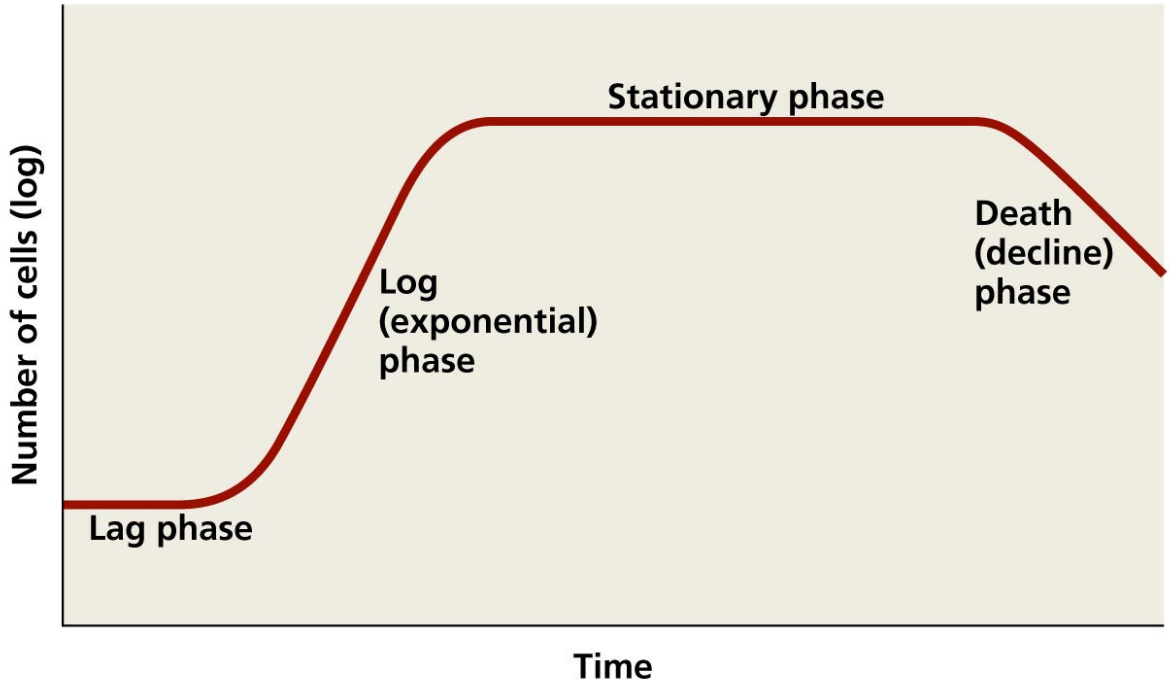
1. **Temperature**: Temperature plays a crucial role in microbial growth. Different microorganisms have specific temperature ranges at which they thrive. Microorganisms can be categorized based on their temperature requirements:
    - **Psychrophiles**: Grow at low temperatures (0-20°C).
    - **Mesophiles**: Grow at moderate temperatures (20-45°C). Many pathogenic bacteria fall into this category.
    - **Thermophiles**: Grow at high temperatures (45-80°C).
    - **Hyperthermophiles**: Grow at extremely high temperatures (>80°C), often found in extreme environments like deep-sea hydrothermal vents.
2. **pH (Acidity or Alkalinity)**: Microorganisms have specific pH ranges in which they can grow optimally. The pH of the growth medium must be adjusted to meet the requirements of the microorganism being cultivated. Most bacteria prefer near-neutral pH (around 6.5-7.5), but some can thrive in acidic or alkaline conditions.

3. **Oxygen (Oxygenation)**: Oxygen availability is crucial for many microorganisms, and they can be classified into several categories based on their oxygen requirements:
    - **Aerobes**: Require oxygen for growth.
    - **Anaerobes**: Cannot tolerate oxygen and grow in its absence.
    - **Facultative Anaerobes**: Can grow both in the presence and absence of oxygen.
    - **Microaerophiles**: Require low levels of oxygen.
    - **Aerotolerant Anaerobes**: Can tolerate oxygen but do not use it for growth.
4. **Moisture (Water Activity)**: The availability of water in the growth environment, measured as water activity (aw), is critical for microbial growth. Most microorganisms require a minimum level of moisture to grow, and this parameter is especially important in food preservation to prevent microbial spoilage.
5. **Osmotic Pressure**: Osmotic pressure is the pressure exerted by solute molecules in a solution. Some microorganisms can grow in high-salt environments (halophiles) or in environments with low solute concentrations (osmotolerant). Osmotic pressure can impact the growth of microorganisms in various habitats.
6. **Light (for Phototrophic Organisms)**: Phototrophic microorganisms, such as photosynthetic bacteria and algae, require light as an energy source for growth. Light intensity, wavelength, and photoperiod (duration of light exposure) are important factors.
7. **Pressure (for Barophilic Organisms)**: Barophilic or piezophilic microorganisms are adapted to high-pressure environments, such as deep-sea hydrothermal vents. They require specific pressure conditions for growth and may not grow at normal atmospheric pressure.
8. **Nutrient Availability**: Apart from physical parameters, the availability of nutrients like carbon sources, nitrogen sources, minerals, vitamins, and growth factors is essential for microbial growth.
9. **Stirring or Agitation**: Mixing or stirring of liquid cultures is important to ensure even distribution of nutrients, oxygen, and other factors required for growth.
10. **Surface Area (for Solid Media)**: In solid culture media (e.g., agar plates), the surface area and the depth of the medium can affect microbial growth. Surface area influences the number of colonies that can form.

11. **Incubation Time**: The duration of incubation (the time microorganisms are allowed to grow) is an important parameter, as different microorganisms have varying growth rates.

GROWTH CURVE

A growth curve is a graphical representation of the growth of a population of microorganisms or cells over time under specific environmental conditions. It is a fundamental tool in microbiology and cell biology for studying and understanding the dynamics of population growth. A typical growth curve exhibits several distinct phases as microorganisms or cells progress through their life cycle:



https://varuncnmicro.blogspot.com/2016/09/btb9-bacterial-growth-curve.html

1. **Lag Phase**:

   In the initial phase of the growth curve, microorganisms or cells are introduced into a new environment or culture medium.

   During this lag phase, there is little to no increase in population size. Instead, cells are adjusting to the new environment, synthesizing enzymes required for growth, and preparing for exponential growth.

   This phase can vary in duration depending on factors like the health of the inoculum and the complexity of the culture medium.

2. **Exponential (Log) Phase**:

   The exponential phase is characterized by rapid and continuous cell division. During this phase, microorganisms or cells are actively multiplying, and the population size increases logarithmically.

   Growth is balanced by cell division and cell death, resulting in a steady increase in cell numbers.

   This phase is often used to estimate the generation time of the microorganism.

3. **Stationary Phase**:

   As the culture medium becomes depleted of nutrients, accumulation of metabolic waste products, or due to other environmental factors, the growth rate starts to slow down.

   The stationary phase is marked by a plateau in the growth curve, indicating that the number of new cells being produced is roughly equal to the number of cells dying.

   In this phase, cell division essentially stops, and the population reaches a state of equilibrium.

4. **Death (Decline) Phase**:

   In this phase, the number of viable cells in the culture begins to decrease.

   The decline phase can occur due to a variety of factors, including nutrient depletion, the buildup of toxic byproducts, or other unfavorable conditions.

   The rate of cell death exceeds the rate of cell division, resulting in a decline in the population size.

University Library Reference-

1. **Prescott microbiology**

- **Suggestions to secure good marks to answer in exam-**
  - Do the classification with formula and example.
  - Explain the answers with key pointsand diagrams.
- **Questions to check the understanding level of students-**
  - Discuss about the nutritional requirements of bacteria.
  - Describe the growth parameter& growth curve.

- **Academic Day ends with-**

  National song ‘Vande- Mataram’