05_Microbial Growth

Microbial Nutrition and Growth

Page 2: Growth Requirements

- **Definition of Microbial Growth**
  - Increase in the population of microbes due to individual reproduction.
  - Results in:
    - **Colony**: Aggregation of cells from a single parent cell.
    - **Biofilm**: Collection of microbes forming a complex community on a surface.

Page 3: Nutrient Sources

- Microbial growth requires various nutrients for energy and cell structures.
- Most common nutrients provide essential elements:
  - Carbon, oxygen, nitrogen, hydrogen.
- Microbes derive nutrients from diverse sources.

Page 4: Types of Organisms by Nutrient Sources

- Organisms classified by carbon sources:
  - **Autotrophs**: Use carbon dioxide.
  - **Heterotrophs**: Obtain organic compounds.
- Classified by energy sources:
  - **Chemotrophs**: Obtain energy from chemical compounds.
  - **Phototrophs**: Obtain energy from light.

Page 5: Carbon and Energy Source Classifications

- **Photoautotrophs**:
  - Plants, algae, cyanobacteria.
  - Use H_2O and CO_2 to produce O_2.
- **Photoheterotrophs**:
  - Use organic compounds for energy.
- **Chemoautotrophs**:
  - Hydrogen, sulfur, nitrifying bacteria.
- **Chemoheterotrophs**:
  - Includes most animals, fungi, protozoa; use aerobic and anaerobic respiration, fermentation.

Page 6: Electron Source Classifications

- Classified by sources of electrons:
  - **Organotrophs**: Obtain electrons from organic sources.
  - **Lithotrophs**: Obtain electrons from inorganic molecules.

Page 7: Oxygen Requirements

- Oxygen is critical for **obligate aerobes** and harmful to **obligate anaerobes**.
- Toxic forms of oxygen are reactive, causing cell damage.

Page 8-9: Toxic Forms of Oxygen

- **Types of Toxic Oxygen Varieties**:
  - **Singlet Oxygen**: Higher energy state molecular oxygen.
  - **Superoxide Radicals**: Form from incomplete O2 reduction.
  - **Peroxide Anion**: Produced during reactions with superoxide dismutase.
  - **Hydroxyl Radical**: Results from ionizing radiation and H2O2 reduction.

Page 10: Catalase Test

- Overview of the test's relevance in determining oxygen requirements.

Page 11: Types of Respiration in Unable Aerobes

- Classification:
  - **Aerobes**: Require oxygen for growth.
  - **Anaerobes**: Thrive without oxygen.
  - **Facultative Anaerobes**: Can switch between aerobic and anaerobic metabolism.
  - **Aerotolerant Anaerobes**: Tolerate oxygen but do not use it.
  - **Microaerophiles**: Require low concentrations of oxygen.

Page 12: Identifying Oxygen Requirements

- Use of liquid thioglycollate growth medium to determine the oxygen preferences of different organisms.

Page 13: Nitrogen Requirements

- Nitrogen is essential for cellular functions; its lack can halt cellular processes.
- Source of nitrogen includes organic and inorganic nutrients; vital for amino acids and nucleotides.
- **Nitrogen Fixation**: Critical process performed by specific bacteria.

Page 14: Other Chemical Requirements

- Additional nutrients necessary for microbial growth:
  - **Phosphorus**
  - **Sulfur**
  - **Trace Elements**: Needed in small amounts, e.g., iron and copper.
  - **Growth Factors**: Organic compounds organisms cannot synthesize.

Page 15: Examples of Growth Factors

- Various growth factors include amino acids, vitamins, and components necessary for metabolic processes.

Page 16: Physical Requirements: Temperature

- Temperature influences protein structure and membrane fluidity.

- Importance of optimal temperature ranges for microbial growth.

Page 17-19: Microbial Growth and Temperature Effects

- Categorization of microbes by temperature preferences:
  - **Psychrophiles**: Cold-loving organisms
  - **Mesophiles**: Moderate temperature organisms
  - **Thermophiles**: Heat-loving organisms
  - **Hyperthermophiles**: Thrive at extremely high temperatures.

Page 20: Physical Requirements: pH

- Microbial sensitivity to acidity changes.
- Organisms classified by pH preferences:
  - **Neutrophiles**: Prefer neutral pH.
  - **Acidophiles**: Thrive in acidic conditions.
  - **Alkalinophiles**: Live in alkaline environments.

Page 21-23: Water Requirements

- Microbes need water for metabolic processes and stability of cellular structures.
- **Osmotic Pressure**: Effects on microorganisms in different solute concentrations.
  - **Hypotonic solutions**: Cells swell.
  - **Hypertonic solutions**: Cells shrink.
- **Hydrostatic Pressure**: Impacts organisms living under extreme conditions; barophiles rely on pressure for cellular integrity.

Page 24-25: Associations and Biofilms

- Relationships in microbial communities:
  - **Antagonistic**: One organism harms another.
  - **Synergistic**: Benefits exceed individual survival.
  - **Symbiotic**: Interdependent relationships; biofilms more resilient than individual organisms.
- Example: Dental plaque as harmful biofilm.

Page 26: Biofilm Development Process

- Stages in biofilm progression from free swimming to a complex community, aided by quorum sensing.

Page 27: Culturing Microorganisms

- **Inoculum**: Introduction of microorganisms into culture media.
- Sources of inoculum: Environmental, clinical, stored specimens.

Page 28: Characteristics of Bacterial Colonies

- Various colony types: shape, margin, elevation, texture, pigment.

Page 29: Clinical Specimen Collection Methods

- Methods for collecting clinical specimens from various body parts and tissues to minimize contamination.

Page 30-34: Obtaining Pure Cultures

- **Pure cultures**: Arised from a single progenitor; maintained through aseptic techniques.
- Isolation techniques include streak plates and pour plates for culture establishment.

Page 35: Types of Culture Media

- Overview of general types of culture media used for cultivating microorganisms:
  - Defined, complex, selective, differential, anaerobic, and transport media.

Page 36-39: Defined and Complex Media

- **Defined Media**: Exact chemical composition known; supports specific organisms.
- **Complex Media**: Nutrients from partially digested sources; suitable for various microorganisms.

Page 40-42: Selective and Differential Media

- **Selective Media**: Promotes growth of particular microorganisms.
- **Differential Media**: Distinguishes between different types based on metabolic properties.

Page 43-48: Enrichment and Transport Media

- **Enrichment Media**: Increase organism numbers to observable levels.
- **Transport Media**: Ensure specimen viability and prevent contamination during transport.

Page 49-51: Special Culture Techniques

- Techniques for culturing organisms that need particular environments or medium types (e.g., low-oxygen culture, and animal cell culture).

Page 52-56: Growth of Microbial Populations

- **Generation Time**: Time for a microbial cell to grow and divide varies by conditions.
- Includes understanding growth curves: lag, log, stationary, and decline phases.

Page 57: Continuous Culture in a Chemostat

- **Chemostat**: Maintains microbes in a growth phase with controlled nutrient levels.

Page 58-62: Measuring Microbial Reproduction

- **Direct Methods**: Microscopic counts and electronic counters for microbial quantification.
- **Indirect Methods**: Assessing turbidity and metabolic activity to estimate growth.

Page 63-67: Serial Dilutions and Membrane Filtration

- Methods used for estimating microbial population size through systematic dilutions and filtration techniques.