Chapter 7
Elements of Microbial Nutrition, Ecology, and Growth
Chapter Outline

7.1. Microbial Nutrition
A. Chemical analysis of microbial cytoplasm
   1. Water
   2. Proteins
   3. Organic compounds
   4. Bioelements
B. Essential nutrients
   1. Carbon
      a. Heterotroph
      b. Autotroph
   2. Nitrogen
   3. Oxygen
   4. Hydrogen
   5. Phosphorus (phosphate)
   6. Sulfur
   7. Other nutrients important in microbial metabolism
   8. Growth factors: Essential organic nutrients
      a. Growth factor
      b. Essential amino acids
   9. How microbes feed: Nutritional types
      a. Phototrophs
      b. Chemotrophs
   10. Autotrophs and their energy sources
      a. Photoautotrophs
      b. Chemoautotrophs
   11. Heterotrophs and their energy sources
      a. Chemoheterotrophs
      d. Parasitic microorganisms
         i. Pathogens
         ii. Obligate parasites
         iii. Obligate intracellular parasite
C. Transport mechanisms for nutrient absorption
D. The movement of water: Osmosis
   1. Selectively or differentially permeable membranes
   2. Tonicity conditions (concentration)
      a. Isotonic
      b. Hypotonic
      c. Hypertonic
      d. Direction of net water movement and osmotic pressure
   3. Adaptations to osmotic variations in the environment
E. The movement of molecules: Diffusion and transport
   1. Diffusion
      a. Simple diffusion
      b. Facilitated diffusion
F. Active transport: Bringing in nutrients against a gradient
   1. Sodium, potassium, and hydrogen pumps
   2. Group translocations
   3. Endocytosis: Eating and drinking by cells
a. Phagocytosis
b. Pinocytosis

7.2. Environmental Factors That Influence Microbes
A. Temperature adaptations
   1. Minimum, optimum, and maximum temperature
   2. Psychrophile
   3. Mesophile
   4. Thermophile
B. Gas requirements
   1. How microbes process oxygen
      a. Aerobe
      b. Obligate aerobe
      c. Facultative anaerobe
      d. Microaerophile
      e. Anaerobe
      f. Strict or obligate anaerobe
      g. Aerotolerant anaerobes
   2. Capnophiles—higher CO₂
C. Effects of pH
   1. Acidophiles
   2. Alkalinothilopes
D. Osmotic pressure
   1. Halophiles
   2. Facultative halophiles
F. Ecological associations among microorganisms
   1. Symbiosis
   2. Mutualism
   3. Commensalism
   4. Parasitism
   5. Synergism
   6. Antagonism
      a. Antibiosis
      b. Bacteriocidins
G. Interrelationships between microbes and humans
   1. Normal microbial flora
   2. Lactobacillus spp in vagina

7.3. The Study of Microbial Growth
A. The basis of population growth: Binary fission
B. The rate of population growth
   1. Generation or doubling time
   2. Mycobacterium leprae and Salmonella enteriditis
   3. Exponential: Geometric
C. The population growth curve
D. Stages in the normal growth curve (Fig. 7.15)
   1. Lag phase
   2. Exponential or log phase
   3. Stationary phase
   4. Death phase
E. Other methods of analyzing population growth
   1. Turbidity assessment
   2. Enumeration of bacteria
      a. Direct or total cell count
b. Cytometer counting