

MICROBIAL METABOLISM

OUTLINE

- I. Nutrient Requirements
- II. Laboratory Culture
- III. Aseptic Technique
- IV. Energy Classes of Microorganisms
- V. Metabolism
 - a. Catabolism
 - b. Anabolism
- VI. Enzymes
- VII. Energy Conservation
- VIII. Glycolysis
- IX. Fermentation
- X. Respiration
 - a. Krebs Cycle
 - b. Proton Motive Force
- XI. Biosyntheses
- XII. Nitrogen Fixation

NUTRIENT REQUIREMENTS

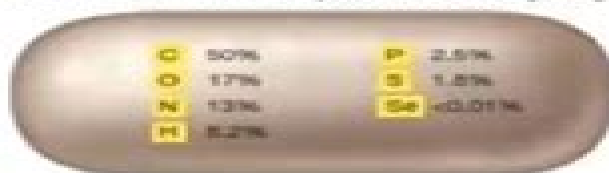
Metabolism

- All biochemical reactions in a living cell
- By which a microorganism obtains energy and nutrients in order to grow, reproduce, and survive.

Nutrient Requirements

- All microbes require Carbon source.
- All organisms require energy.
- Nitrogen is universally required – component of proteins, nucleic acid, phospholipids both chitin and murein.
- Sulfur is obligatory required – essential part of both methionine and cysteine.
- Phosphorous is uniformly required – component of essential cell components such as the nucleic acid, teichoic and teichuronic acids, and phospholipid.
- Water is required – constitutes the majority of the cell's weight.
- Minerals are required primarily to facilitate critical cell activities such as enzyme reactions or transported processes.

Essential elements as a percent of cell dry weight



- Around 70-80% of wet weight is water

Macromolecular composition of a cell

Macromolecule	Percent of dry weight
Protein	55
Lipid	9.1
Polysaccharide	5.0
Lipopolysaccharide	3.4
DNA	3.1
RNA	20.5

- Proteins dominate the macromolecular composition of the cell.

Micronutrients needed by microorganisms

Trace Elements	
Element	Function
Boron (B)	Autoinducer for quorum sensing in bacteria, also found in some polyketide antibiotics
Cobalt (Co)	Vitamin B ₁₂ ; transcarboxylase (only in propionic acid bacteria)
Copper (Cu)	In respiration, cytochrome c oxidase; in photosynthesis, plastocyanin, some superoxide dismutases
Iron (Fe) ²⁺	Cytochromes; catalases; peroxidases; iron-sulfur proteins; oxygenases; all nitrogenases
Manganese (Mn)	Activator of many enzymes; component of certain superoxide dismutases and of the water-splitting enzyme in oxygenic phototrophs (photosystem II)
Molybdenum (Mo)	Certain flavin-containing enzymes; some nitrogenases, nitrate reductases, sulfite oxidases, DMSO-TMAO reductases; some formate dehydrogenases
Nickel (Ni)	Most hydrogenases; coenzyme F ₄₃₀ of methanogens; carbon monoxide dehydrogenase; urease
Selenium (Se)	Formate dehydrogenase; some hydrogenases; the amino acid selenocysteine
Tungsten (W)	Some formate dehydrogenases; oxotransferases of hyperthermophiles
Vanadium (V)	Vanadium nitrogenase; bromoperoxidase
Zinc (Zn)	Carbonic anhydrase; nucleic acid polymerase; many DNA-binding proteins

- They are called trace metals because they are required in such small amounts.
- Enzymes with a trace metal requirement may be synthesized by the cell but will not function properly if the cell is starved for these metals.

Growth Factors

Growth Factor	Function
PABA (p-aminobenzoic acid)	Precursor of folic acid
Folic acid	One-carbon metabolism; methyl transfers
Biotin	Fatty acid biosynthesis; some CO ₂ fixation reactions
B ₁₂ (Cobalamin)	One-carbon metabolism; synthesis of deoxyribose
B ₁ (Thiamine)	Decarboxylation reactions
B ₅ (Pantoic acid)	Amino acid/ keto acid transformations
Nicotinic acid (Niacin)	Precursor of NAD ⁺
Riboflavin	Precursor of FMN, FAD
Pantothenic acid	Precursor of coenzyme A
Lipoic acid	Decarboxylation of pyruvate and α-ketoglutarate
Vitamin K	Electron transport
Coenzymes M and B	Methanogenesis ²
F ₄₃₀ and F ₄₃₂	Methanogenesis ²

- Growth factors are organic micronutrients rather than metals.

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Table of Contents Study Guide Microbiology Microbial Metabolism

1. Understanding the eBook Study Guide Microbiology Microbial Metabolism
 - The Rise of Digital Reading Study Guide Microbiology Microbial Metabolism
 - Advantages of eBooks Over Traditional Books
2. Identifying Study Guide Microbiology Microbial Metabolism
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Study Guide Microbiology Microbial Metabolism
 - User-Friendly Interface
4. Exploring eBook Recommendations from Study Guide Microbiology Microbial Metabolism
 - Personalized Recommendations
 - Study Guide Microbiology Microbial Metabolism User Reviews and Ratings
 - Study Guide Microbiology Microbial Metabolism and Bestseller Lists
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 - Study Guide Microbiology Microbial Metabolism Enhanced eBook Features
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 - Interactive Elements Study Guide Microbiology Microbial Metabolism
- 8. Staying Engaged with Study Guide Microbiology Microbial Metabolism
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Study Guide Microbiology Microbial Metabolism
- 9. Balancing eBooks and Physical Books Study Guide Microbiology Microbial Metabolism
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Study Guide Microbiology Microbial Metabolism
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Study Guide Microbiology Microbial Metabolism
 - Setting Reading Goals Study Guide Microbiology Microbial Metabolism
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Study Guide Microbiology Microbial Metabolism
 - Fact-Checking eBook Content of Study Guide Microbiology Microbial Metabolism
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development

- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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