

MICROBIAL METABOLISM

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NUTRIENT REQUIREMENTS

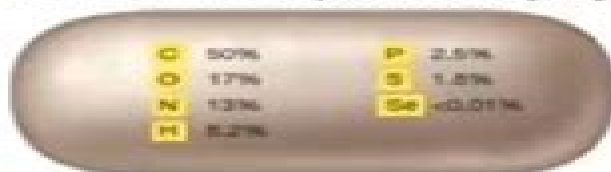
Metabolism

- 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

Element	Trace Elements
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
B₁₂ (Cobalamin)	One-carbon metabolism; synthesis of deoxyribose
B₁ (Thiamine)	Decarboxylation reactions
B₅ (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
F₄₃₀ and F₄₃₂	Methanogenesis ²

- Growth factors are organic micronutrients rather than metals.

Study Guide Microbiology Microbial Metabolism

George A. Wistreich



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Manual in General Microbiology, 1926 **Microbiology** Gerard J. Tortora, Berdell R. Funke, Christine L. Case, 1982 Since the publication of the first edition nearly 30 years ago well over 1 million students have used *Microbiology: An Introduction* at colleges and universities around the world making it the leading microbiology textbook for non majors The fourteenth edition continues to be a comprehensive beginning text assuming no previous study of biology or chemistry The text is appropriate for students in a wide variety of programs including the allied health sciences biological sciences environmental science animal science forestry agriculture nutrition science and the liberal arts *Laboratory Manual in General Microbiology* Michigan State University. Department of Bacteriology and Public Health, 1921 *Microbe*, 2006 *Laboratory Manual in General Microbiology* Michigan Agricultural College. Department of Bacteriology and Hygiene, 1921 The full text of the first edition 1916 is available at <http://www.biodiversitylibrary.org/item/62094> *Principles and Applications of Soil Microbiology* David M. Sylvia, 2005 9411G 9 0 13 094117 4 Sylvia David M Fuhrmann Jeffry J Hartel Peter G Zuberer David A Principles and Applications of Soil Microbiology 2 E Written by leading experts in their respective fields this comprehensive balanced introduction to soil microbiology captures the rapid advances in the study of soil microbiology e g habitats and organisms microbially mediated transformation and applied environmental topics Carefully edited for ease of reading it aids users by providing an excellent multi authored reference the type of book that is continually used in the field Background information is provided in the first part of the book for ease of comprehension it then describes such fundamental topics as soil environment and microbial processes microbial groups and their interactions and thoroughly addresses critical nutrient cycles and important environmental and agricultural applications An excellent desk reference and useful tool for certified professional soil scientists environmental scientists and others that effect environmental policy such as soil erosion and maintenance specialists *Geomicrobiological Properties and Processes of Travertine* Akihiro Kano, Tomoyo Okumura, Chizuru Takashima, Fumito Shiraishi, 2018-09-20 This book presents basic knowledge and key objectives of research of geological geochemical and microbial properties and processes in travertines carbonate deposits precipitated from calcareous hot springs Much of the contents are based on the authors researches performed in Japan and Indonesia over the last decade Travertine is one of the most active sedimentary systems which have a potential impact on the Earth s environment It is also an accessible epitome of the Earth s history cultivating ancestral bacteria and representing a modern analog for ancient stromatolites Readers can learn how integration of various scopes and methods unveils mysterious phenomena in travertine and can find clues for considering the early history of the Earth and life This book includes a monographic chapter on Japanese onsens or hot springs which may help tourists to select the best places to enjoy the unique features of travertine *Subject Guide to Books in Print*, 2001 *Microbial Ecology* Ronald M. Atlas, Richard Bartha, 1998 The 4th edition of *Microbial Ecology* features enhanced coverage of biofilms thermal vent communities extreme habitats starvation response molecular methods for studying microbial ecology and biodiversity biodegradation and bioremediation

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