

MICROBIAL METABOLISM

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NUTRIENT REQUIREMENTS

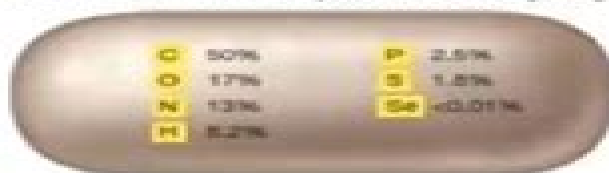
Metabolism

- 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	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
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.

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Robert R. Redfield



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