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The nutritional

By

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The nutritional requirements for bacteria

Every organism must find in its environment all of the substances required for energy generation and cellular biosynthesis. The chemicals and elements of this environment that are utilized for bacterial growth are referred to as nutrients or nutritional requirements. In the laboratory, bacteria are grown in culture media which are designed to provide all the essential nutrients in solution for bacterial growth .

Mineral Nutrients:

The microbial nutrients can be classified as macro (major) nutrients, and micro (minor) nutrients or trace elements on the basis of their amount required.

1. Macro or Major Mineral Nutrients:

The microbial cells contain water accounting for some 80-90% of their total weight and, therefore, the water is always the major essential nutrient in quantitative terms. The solid matter of cells contain, in addition to oxygen and hydrogen (derivable metabolically from water), the other macro (major) elements, namely, carbon, nitrogen, phosphorus, sulphur, potassium, magnesium, sodium, calcium and iron in order of decreasing abundance. About 95% of cellular dry weight of

microbial cells is accounted for only six macro (major) elements (O, H, C, N, P and S).

2. Micro or Minor Mineral Nutrients or Trace Elements:

The microorganisms, in general do not use only macro (major) elements but also others like cobalt, copper, manganese, molybdenum, nickel, selenium, tungsten, vanadium and zinc which are required in residual fraction by nearly all microorganisms. These elements are often referred to as minor (micro) nutrients or trace elements. The micronutrients or trace elements are nevertheless just as critical to cell function as are the macronutrients (Table 1) .

Minor elements found in microbial cells with their functions and predominant chemical form used by microorganisms

Element	Atomic number	Chemical form used by microbes	Function
Mn	23	Mn^{2+}	superoxide dismutase, photosystem II
Co	27	Co^{2+}	coenzyme B_{12}
Ni	28	Ni^{+}	hydrogenase, urease
Cu	29	Cu^{2+}	cytochrome oxidase, oxygenase
Zn	30	Zn^{2+}	alcohol dehydrogenase, aldolase, alkaline phosphatase, RNA and DNA polymerase, arsenate reductase
Se	34	SeO_3^{2-}	formate dehydrogenase, glycine reductase
Mo	42	MoO_4^{2-}	nitrogenase, nitrate reductase, formate dehydrogenase, arsenate reductase
W	74	WO_4^{2-}	formate dehydrogenase, aldehyde oxidoreductase

Carbon and energy sources for bacterial growth

All living organisms require a source of energy. Organisms that use radiant energy (light) are called phototrophs. Organisms that use (oxidize) an organic form of carbon are called heterotrophs or chemo(hetero) trophs. Organisms that oxidize inorganic compounds are called lithotrophs. The carbon requirements of organisms must be met by organic carbon (a chemical compound with a carbon-hydrogen bond) or by CO_2 . Organisms that use organic carbon are heterotrophs and organisms that use CO_2 as a sole source of carbon for growth are called autotrophs. Thus, on the basis of carbon and energy sources for growth four major nutritional types of procaryotes may be defined (Table 2)

(Table 2.) Major nutritional types of procaryotes.

Nutritional Type	Energy Source	Carbon Source	Examples
Photoautotrophs	Light	CO_2	Cyanobacteria, some Purple and Green Bacteria
Photoheterotrophs	Light	Organic compounds	Some Purple and Green Bacteria
Chemoautotrophs or Lithotrophs	Inorganic compounds	CO_2	A few Bacteria and

(Lithoautotrophs)	**, e.g. H_2, NH_3, NO_2, H_2S**		**many Archaea**
Chemoheterotrophs or Heterotrophs	**Organic compounds**	**Organic compounds**	**Most Bacteria, some Archaea**

Almost all eukaryotes are either photoautotrophic (e.g. plants and algae) or heterotrophic (e.g. animals, protozoa, fungi). Lithotrophy is unique to procaryotes and photoheterotrophy, common in the purple and green Bacteria, occurs only in a very few eukaryotic algae. Phototrophy has not been found in the Archaea.

This simplified scheme for use of carbon, either organic carbon or CO_2 , ignores the possibility that an organism, whether it is an autotroph or a heterotroph, may require small amounts of certain organic compounds for growth because they are essential substances that the organism is unable to synthesize from available nutrients. Such compounds are called growth factors.

Growth Factors:

Besides the mineral nutrients, the microorganisms need some organic compounds. Most of the microorganisms are capable of synthesizing these organic compounds from simpler carbon resources, others cannot and need their supply from outside for their proper growth and development.

Organic nutrients of this type are known collectively as growth factors (essential metabolites) and can be categorized into three groups (amino acids, purines and pyrimidines and vitamins) on the basis of their chemical structure and metabolic function. Amino acids and purines and pyrimidines are the constituents of proteins and nucleic acids, respectively. Vitamins, however, are the most commonly needed growth factor and form parts of the prosthetic groups or active centres of certain enzymes.

Table (3) . Common vitamins required in the nutrition of certain procaryotes.

Vitamin	Coenzyme form	Function
Folic acid	Tetrahydrofolate	Transfer of one-carbon units and required for synthesis of thymine, purine bases, serine, methionine and pantothenate
Biotin	Biotin	**Biosynthetic reactions that require CO_2 fixation**
Nicotinic acid	NAD (nicotinamide adenine dinucleotide) and NADP	Electron carrier in dehydrogenation reactions
Riboflavin (B2)	FMN (flavin mononucleotide) and FAD (flavin adenine dinucleotide)	**Oxidoreduction reactions**
Thiamine (B1)	Thiamine pyrophosphate (TPP)	**Decarboxylation of keto acids and transaminase reactions**
Vitamin B12	Cobalamine coupled to adenine nucleoside	Transfer of methyl groups
Vitamin K	Quinones and	**Electron transport processes**