NovaQ10

Coenzyme Q10

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Summary

Coenzyme Q10 is a fat-soluble compound primarily synthesized by the body and also consumed in the diet.
Coenzyme Q10 is required for mitochondrial ATP synthesis and functions as an antioxidant in cell membranes and lipoproteins.
Endogenous synthesis and dietary intake appear to provide sufficient coenzyme Q10 to prevent deficiency in healthy people, although tissue levels of coenzyme Q10 decline with age.
Oral supplementation of coenzyme Q10 increases plasma, lipoprotein, and blood vessel levels, but it is unclear whether tissue coenzyme Q10 levels are increased, especially in healthy individuals. Coenzyme Q10 supplementation has resulted in clinical and metabolic improvement in some patients with hereditary mitochondrial disorders.
Although coenzyme Q10 supplementation may be a useful adjunct to conventional medical therapy for congestive heart failure, additional research is needed.
Roles for coenzyme Q10 supplementation in cardiovascular diseases, neurodegenerative diseases, cancer, and diabetes require further research.
Coenzyme Q10 supplementation does not appear to improve athletic performance.
Although coenzyme Q10 supplements are relatively safe, they may decrease the anticoagulant efficacy of warfarin.
Although the use of cholesterol-lowering medications known as HMG-CoA reductase inhibitors (statins) decreases circulating levels of coenzyme Q10, it is unclear whether coenzyme Q10 supplementation provides any health benefit to patients taking these drugs.

Introduction

Coenzyme Q10 is a member of the ubiquinone family of compounds. All animals, including humans, can synthesize ubiquinones, hence, coenzyme Q10 cannot be considered a vitamin (1). The name ubiquinone refers to the ubiquitous presence of these compounds in living organisms and their chemical structure, which contains a functional group known as a benzoquinone. Ubiquinones are fat-soluble molecules with anywhere from one to 12 isoprene (5-carbon) units. The ubiquinone found in humans, ubidecaquinone or coenzyme Q10, has a "tail" of ten isoprene units (a total of 50 carbon atoms) attached to its benzoquinone "head" (diagram) (2).

Function

Coenzyme Q10 is soluble in lipids (fats) and is found in virtually all cell membranes, as well as lipoproteins (2). The ability of the benzoquinone head group of coenzyme Q10 to accept and donate electrons is a critical feature in its biochemical functions. Coenzyme Q10 can exist in three oxidation states (diagram): (1) the fully reduced ubiquinol form (CoQ10H2), (2) the radical semiquinone intermediate (CoQ10H·), and (3) the fully oxidized ubiquinone form (CoQ10).

Mitochondrial ATP synthesis

The conversion of energy from carbohydrates and fats to adenosine triphosphate (ATP), the form of energy used by cells, requires the presence of coenzyme Q in the inner mitochondrial membrane. As part of the mitochondrial electron transport chain, coenzyme Q accepts electrons from reducing equivalents generated during fatty acid and glucose metabolism and then transfers them to electron acceptors. At the same time, coenzyme Q transfers protons outside the inner mitochondrial membrane, creating a proton gradient across that membrane. The energy released when the protons flow back into the mitochondrial interior is used to form ATP (2).

Lysosomal function

Lysosomes are organelles within cells that are specialized for the digestion of cellular debris. The digestive enzymes within lysosomes function optimally at an acid pH, meaning they require a permanent supply of protons. The lysosomal membranes that separate those digestive enzymes from the rest of the cell contain relatively high concentrations of coenzyme Q10. Research suggests that coenzyme Q10 plays an important role in the transport of protons across lysosomal membranes to maintain the optimal pH (2, 3).

Antioxidant functions

In its reduced form, CoQ10H2 is an effective fat-soluble antioxidant. The presence of a significant amount of CoQ10H2 in cell membranes, along with enzymes that are capable of reducing oxidized CoQ10 back to CoQ10H2, supports the idea that CoQ10H2 is an important cellular antioxidant (2). CoQ10H2 has been found to inhibit lipid peroxidation when cell membranes and low-density lipoproteins (LDL) are exposed to oxidizing conditions outside the body (ex vivo). When LDL is oxidized ex vivo, CoQ10H2 is the first antioxidant consumed. Moreover, the formation of oxidized lipids and the consumption of alpha-tocopherol (alpha-TOH, biologically the most active form of vitamin E) are suppressed while CoQ10H2 is present (4). In isolated mitochondria, coenzyme Q10 can protect membrane proteins and DNA from the oxidative damage that accompanies lipid peroxidation (1). In addition to neutralizing free radicals directly, CoQ10H2 is capable of regenerating alpha-TOH from its one-electron oxidation product, alpha-tocopheroxyl radical (alpha-TO·).