Investigation of Coenzyme Q10 As An Anti-Aging Supplement

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Abstract

Coenzyme Q10 (CoQ10) is recognized as an important coenzyme, or semi-vitamin, that functions in many capacities in aerobic organisms. Of specific importance is CoQ10's function as an electron carrier in the electron transport chain in mitochondria, which is responsible for the production of ATP. In that process, CoQ10 contributes to the translocation of protons from the mitochondrial matrix to the inter-membrane space, thereby creating a proton gradient, which is the crux of ATP generation. Consumption of CoQ10 in supplements has become a growing trend meant to enhance bioenergetic capacity and mitigate adverse effects of aging related to certain pathological conditions. I hypothesize that exogenous intake of CoQ10 through a CoQ10 supplement will be ineffective against aging and may have hazardous side effects. Preliminary results suggest that CoQ10 does not mitigate aging, and is damaging in high dosages.

Introduction

CoQ is a lipohilic, redox molecule located within the phospholipid bilayer of cellular membranes (4). In mitochondria, CoQ10 is located within the inner membrane and functions to drive the creation of the transmembrane proton gradient, which is the crux of aerobic respiration and drives ATP generation (4,6,8) CoQ10 can exist in three stable oxidation states, which is important for its biosynthesis and its role in aerobic respiration. These states include the fully reduced ubiquinol form (CoQ10H2), the radical semiquinone intermediate (CoQ10H·), and the fully oxidized ubiquinone form (CoQ10) (3,6,7). While the CoQ intermediate (CoQ10H·) is a requisite for aerobic respiration, it is also the primary source of mitochondrial superoxide anion radical production, which promulgates oxidative damage and thus aging (4,6,7,8). Because CoQ10 functions as both an essential component of the electron transport chain and as the primary source of mitochondrial radical production, it is unclear whether increased exogenous intake will prolong or curtail lifespan (4).

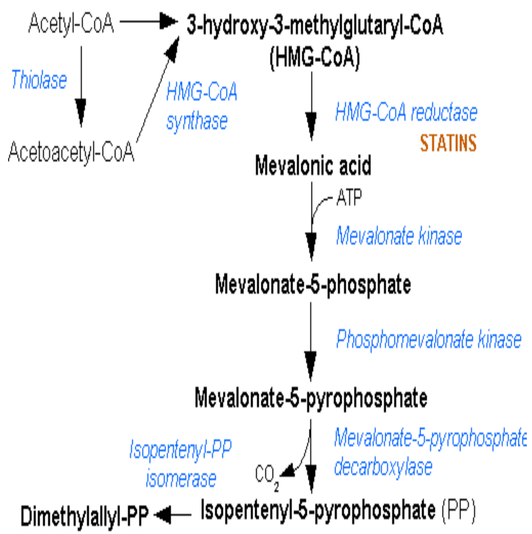

Figure 1: Mevalonate Pathway; Biosynthesis of CoQ
Mevalonate is a precursor to isopentenyl pyrophosphate, which combines with its isomer, dimethylallyl pyrophosphate, in repeating alternations to form isoprene (or polyprenyl) chains.

http://en.wikipedia.org/wiki/File:Mevalonate_pathway.png

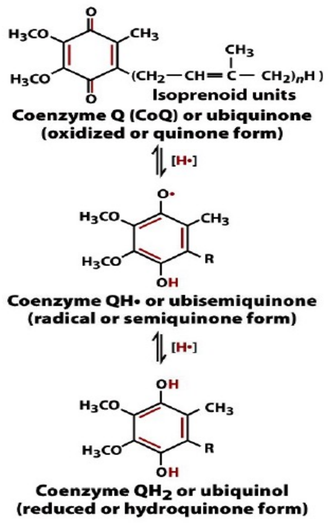

Figure 2: CoQ10 oxidation states
This is how CoQ acts as an electron carrier in the ETC transferring a high energy electron

http://biology.ucsd.edu/classes/bibc102.SU2.08/objects/ch05-OxPhos.pdf

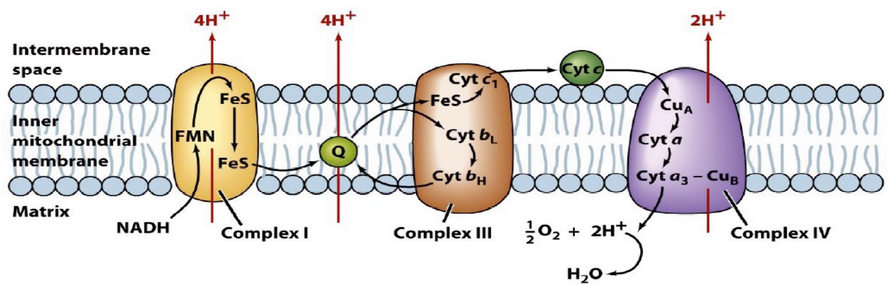

Figure 3: Electron Transport Chain (ETC)
The ETC is a series of linked electron carriers in mitochondria, leading to the eventual reduction of O_2 to H_2O and the creation of an electrochemical proton gradient, which is utilized in oxidative phosphorylation to synthesize stored energy as ATP. Complex I passes electrons from NADH to CoQ, Complex II passes electrons from succinate to CoQ, CoQ passes its electrons to cytochrome c in complex III and then water is reduced in Complex IV.

http://biology.ucsd.edu/classes/bibc102.SU2.08/objects/ch05-OxPhos.pdf

Methods

A literature review of peer-reviewed journal articles was conducted.

Results

Early evidence suggests that there are possible benefits of CoQ10 in ameliorating some disease states. Various diseases including Huntington's and Parkinson's involve decreased concentrations of CoQ10, and early clinical trials in humans with these diseases suggest that a low dosage CoQ supplementation may be benefical (3, 4, 11,13-17). It is not known, however, if the decreased concentratons are a cause or effect of the disease (11). Furthermore, a mouse model was used to determine adverse effects of CoQ10 supplemenation and found that at high dosage, 2.6 mg/g, cognitive and sensory impairments encountered in old mice were exacerbated (4). Additionally, supplements of CoQ10 in both high and low dosages, 0.68 mg/g and 2.0 mg/g, had no significant effect on survival (p>.565) (4). There is no evidence to suggest a direct correlation between CoQ intake and prolonged life span (4,8,9,11,12).

Discussion

From the preliminary data I would suggest that a healthy person should not take CoQ10 supplements. The assertion that the supplements delay aging is unsubstantiated and safe and effective dosages have not been established in a human model. Furthermore, the adverse effects of a high dosage outweigh the possible benefits.

Conclusion

CoQ10 supplements are new and have had little clinical evaluation. Research conducted thus far has had small sample sizes or were based on mouse models. Therefore, CoQ10 supplements have not been shown to be safe nor proven beneficial. A health provider should be advised when an individual is considering taking a CoQ10 supplement, and a risk benefit analysis should be undertaken.

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