UBIQUINONE and UBIQUINOL

(Active forms of Coenzyme Q10)

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In the body, Coenzyme Q10 (CoQ10) in found in two active forms (*Oxidized* and *Reduced*). The oxidized form is called *Ubiquinone* and the reduced form *Ubiquinol*. Ubiquinone was isolated from beef heart mitochondria fifty years ago (1957) by Dr Fred Crane. Reduced CoQ10 is formed by the action of reducing agents on the oxidized form. These agents are found in the absorption cells, lymph, blood or all other living cells. Both forms of CoQ are found in all living cells of the animal, plant and microorganism kingdoms. Man and larger animals have the CoQ10 analog while smaller animals (rodents) and plants have CoQ9. Most microorganisms such as yeast and bacterium have CoQ6 except for one known friendly bacterium which produces CoQ10. Although the body cells make ubiquinone, it is rapidly converted to ubuquinol. This reduced form makes up 90 to 95 percent of the total body CoQ10. Ubiquinone, in the crystalline form, is very stable whereas in the past commercially manufactured ubiquinol was unstable. Ubiquinone entered the supplement market in about 1974. Ubiquinol entered the market in 2006.

Ubiquinone functions as cofactor stimulation for the synthesis of energy in the electron transport system located in the inner membrane of the mitochondria. It is responsible for 95 percent of the energy produced in the cell by a process called *oxidative phosphorlation*. This energy created is essential for life, since without ubiquinone – energy synthesis life forms using oxygen in the metabolic process would cease to exist.

Ubiquinol functions as an antioxidant in the lymph, blood and in the phospholipid membranes of cells and cell organelles. It is one of many antioxidants produced by the body and is found in many of the foods we eat. When working as an antioxidant, it gives up an electron (hydrogen atom) to neutralize: toxic superoxides and free radicals produced in metabolic processes, found in foods, and in environment pollutants. When ubiquinol functions as an antioxidant it cycles to the ubiquinol form. Since the body produces many antioxidants, in addition to others obtained from the foods we eat, it is not known if ubiquinol is essential for life. However, its high levels in lymph, blood, cell and cell organelles membranes does suggest it may be the primary lipid antioxidant responsible preventing lipid peroxidation and destruction of these membranes. This functional capacity occurs in all age groups, but may be more effective in the elderly groups. It is they who may have deficient reducing agents to convert ubiquinone to ubiquinol. To date these groups have not been well defined.

Again, both forms of CoQ10 have uniquely different functions and as such one form is no more bioactive than the other. The important thing to note is that ubiquinol and ubiquinone do not work independently. They are what we called a *redox* (oxidation-reduction) pairs. Meaning, one cannot exist without the other. In their respective functions, one recycles to the other and vice versa. For example, the body does not store large quantities of energy as adenosine triphosphate (ATP). To produce ATP rapidly, ubiquinone gives up an electron along with NADH and Cytochrome C to run the electron transport system. In this process, ubiquinol is formed and in the presence of free radicals and superoxides produced in the metabolic processes, gives up an electron and is thus recycled back to ubiquinone. The same redox relationship occurs when supplemental ubiquinone is absorbed in the intestines; where immediately after being absorbed, the oxidized CoQ10 is converted (in the presence of