



was reported by Dr. [Karl Folkers](#) and coworkers at [Merck](#); in 1968, Folkers became a Professor in the Chemistry Department at the [University of Texas at Austin](#). In 1961 Peter Mitchell proposed the electron transport chain (which includes the vital protonmotive role of CoQ<sub>10</sub>) and he received a Nobel prize for the same in 1978. In 1972, Gian Paolo Littarru and Karl Folkers separately demonstrated a deficiency of CoQ<sub>10</sub> in human heart disease. The 1980s witnessed a steep rise in the number of clinical trials due to the availability of large quantities of pure CoQ<sub>10</sub> and methods to measure plasma and blood CoQ<sub>10</sub> concentrations. The antioxidant role of the molecule as a free radical scavenger was widely studied by Lars Ernster. Numerous scientists around the globe started studies on this molecule since then in relation to various diseases including cardiovascular diseases and cancer.

CoQ<sub>10</sub> is found in the [membranes](#) of many [organelles](#). Since its primary function in cells is in generating energy, the highest concentration is found on the inner [membrane](#) of the [mitochondrion](#). Some other organelles that contain CoQ<sub>10</sub> include [endoplasmic reticulum](#), [peroxisomes](#), [lysosomes](#), and [vesicles](#). In its reduced form ([ubiquinol](#)), Coenzyme Q<sub>10</sub> acts as an important antioxidant in the body. <sup>[[citation needed](#)]</sup>

### **CoQ<sub>10</sub> and electron transport chain**

CoQ<sub>10</sub>, fat-soluble and therefore mobile in cellular membranes, plays a unique role in the electron transport chain (ETC). In the inner mitochondrial membrane electrons from NADH and succinate pass through the ETC to the oxygen, which is then reduced to water. The transfer of electrons through ETC results in the pumping of H<sup>+</sup> across the membrane creating a proton gradient across the membrane, which is used by ATP synthase (located on the membrane) to generate ATP. CoQ<sub>10</sub> functions as an electron carrier from enzyme complex I and enzyme complex II to complex III in this process. This is crucial in the process, since no other molecule can perform this function. Thus, CoQ<sub>10</sub> functions in every cell of the body to synthesize energy.

### **Antioxidant function of CoQ<sub>10</sub>**

The antioxidant nature of CoQ<sub>10</sub> derives from its energy carrier function. As an energy carrier, the CoQ<sub>10</sub> molecule is continuously going through an oxidation-reduction cycle. As it accepts electrons, it becomes reduced. As it gives up electrons, it becomes oxidized. In its reduced form, the CoQ<sub>10</sub> molecule holds electrons rather loosely, so this CoQ molecule will quite easily give up one or both electrons and, thus, act as an antioxidant. CoQ<sub>10</sub> inhibits lipid peroxidation by preventing the production of lipid peroxy radicals (LOO). Moreover, CoQH<sub>2</sub> reduces the initial peroxyl radical and singlet oxygen, with concomitant formation of ubiquinol and H<sub>2</sub>O<sub>2</sub>. This quenching of the initiating peroxyl radicals, which prevent propagation of lipid peroxidation, protects not only lipids, but also proteins from oxidation. In addition, the reduced form of CoQ effectively regenerates vitamin E from the α-tocopheroxyl radical and, thereby interfering with the propagation step. Furthermore, during oxidative stress, interaction of H<sub>2</sub>O<sub>2</sub> with metal ions bound to DNA generates hydroxyl radicals and CoQ efficiently prevents the oxidation of bases, in particular, in mitochondrial DNA.<sup>[9]</sup> In contrast to other antioxidants, this compound inhibits both the initiation and the propagation of lipid and protein oxidation. It also regenerates other antioxidants such as vitamin E. The circulating CoQ<sub>10</sub> in LDL prevents oxidation of LDL, therefore, by providing its benefits in cardiovascular diseases.

