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## REPORT

**The Multiple Health Benefits of Coenzyme Q10**

By Saul Kent  
President  
Life Extension Foundation

Could you use more energy? Most 10-year-olds are bursting with energy. At age 30 most of us *still* have plenty of energy. By 40 we're beginning to slow down, but experience allows us shortcuts to reduce our energy needs. However by age 60, our energy levels are so depleted that even the wisdom of our years can't make up for our decline. If we make it to 80, we're just a shadow of our former selves. And if we reach 100, we're thrilled just to be alive.

It's not just our body as a whole that needs energy it's our individual cells as well. Our brain cells need energy to think, our heart cells need energy to keep our blood circulating, our lung cells need energy to process oxygen, our kidney cells need energy to excrete waste, our bone and muscle and cells need energy for structure and strength, and our immune cells need energy to fight off invading organisms.

**DEPLETION OF ENERGY**

Although most diseases aren't caused by defects in the generation of energy, they're all *characterized* by energy depletion. Cancer stroke, heart disease, diabetes, and Alzheimer's disease are different in their origin and expression, but they have one thing in common: depletion of the energy-generating capacity of essential cells. Energy depletion caused by diseases produces feelings of weakness, lassitude, depression, despair and hopelessness. Its endpoint is death.

As you know such feelings don't just come from overt diseases. Lack of energy is one of the most common complaints in people of all ages Whether reduced energy is caused by subclinical disease states, unpleasant or traumatic experiences, the "normal" ups and downs of life, or the ravages of aging, the feelings are the same. No one *likes* to feel weak. No one likes to be unable to do things they need to do. No one likes to see life as dark, colorless and unexciting. No one likes pain and suffering. And no one likes to feel as if their life is slipping away from them.

**THE CENTRAL FAILURE IN HUMAN LIFE**

The central failure in human life is weakness: lack of strength; lack of purpose; lack of character; and lack of will. The appropriate reaction to weakness and feelings of inadequacy is to build oneself up, but all too often people strive to tear others down, or to rely on others for their self esteem. The results in social terms have been personal conflict, estrangement, war, and victimization.

**EFFECTS ON HEALTH AND MEDICAL CARE**

The effects on health and medical care have been reliance on doctors to "*cure*" us rather than taking responsibility for our own lives, the focus on the treatment of diseases rather than their prevention, and the attempt to destroy our enemies (viruses, bacteria, and other organisms) rather than to maintain our youth, become stronger, and build up our defenses.

A tragic example of the failure of our medical system is the story of Coenzyme Q, (CoQ<sub>10</sub>)- an essential component of our energy-generating system -- whose structure and function was discovered in the United States in the late 1950s, but whose role in health care has been almost totally ignored by the U.S. medical establishment, except for the heroic efforts of Dr. Karl Folkers of the University of Texas at Austin.

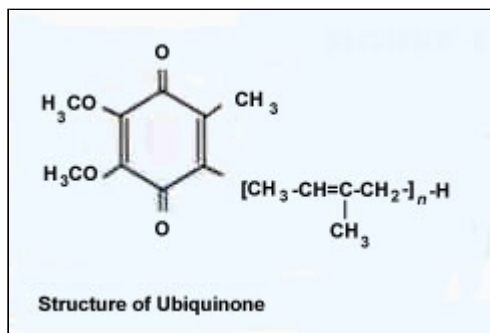
**The Discovery Of Coenzyme Q10**

In 1956, scientists at the University of Wisconsin under Dr. David E. Green isolated a crystalline yellow compound from beef heart

mitochondria (the energy factories of the cell). They gave a few milligrams of this sample to Dr Folkers, who was head of a biochemical research team at Merck Sharp And Dohme Research Laboratories in Rahway, New Jersey.

Dr. Folkers and his coworkers at Merck determined that the chemical structure of CoQ is 2,3-dimethoxy-5-methyl-6-decaprenyl-1,4-benzoquinone. This structure was revealed at the International Congress on Biochemistry in Vienna in 1958 and published that year in the Journal of the American Chemical Society (60:4752).

**FIGURE 1**



Their discovery was given the name Coenzyme Q<sub>10</sub> because it has the biochemical role of a coenzyme (it aids in the action of enzymes) because the letter Q is the first letter of the word quinone, and because it has 10 isoprenoid units on its side chain (figure 1). Dr R.A. Morton and associates at the University of Liverpool in England named CoQ ubiquinone in their 1958 paper in *Nature* (182:1764) because it is found in virtually every cell of the body.

### CONCENTRATION AND BIOSYNTHESIS OF COQ

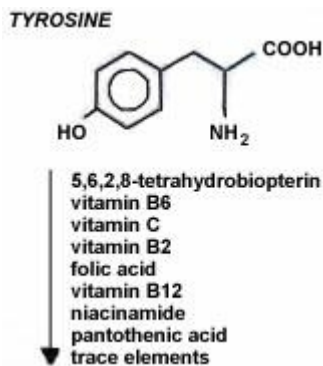
CoQ is found in high concentrations (bound to three different proteins) in the heart, liver kidney, and pancreas. The total body content of CoQ has been estimated to be 0.5-1.5 grams. About 50% of the CoQ in the body is found within the mitochondria, where energy is generated on a continuous basis, and where CoQ has three major functions: to help several mitochondrial enzymes convert dietary nutrients (in the presence of oxygen) into the energy "currency" of the body ATP (Adenosine Triphosphate); to help quench some of the free radicals generated in the energy making process; and to help protect the integrity of the mitochondrial membrane.

CoQ levels have been shown to be well below normal in patients with a wide variety of diseases including heart disease, cancer and muscular dystrophy, as well as in normally aging people. One likely reason for these age and disease-related declines in CoQ may be the complexity of the process by which CoQ is synthesized within the body.

CoQ is biosynthesized from the amino acids phenylalanine and tyrosine with the help of at least eight vitamins and trace elements (figure 2) all of which have vital biochemical functions in the body in addition to the manufacture of CoQ. Anyone with deficiencies of any of these nutrients is likely to become deficient in CoQ. When you add the aging-related breakdown of mitochondrial function which includes unreparable DNA mutations - it's no wonder that our bodies hunger so much for this remarkable, life-enhancing nutrient.

**Figure 2**

The steps in the sequence for the biosynthesis of vitamin Q<sub>10</sub> from phenylalanine in the human body have eight aromatic intermediates.



### THE JAPANESE TAKE THE LEAD

The fact that CoQ is available in the United States today to prevent killer diseases and extend lifespan is because of pioneering efforts in Japan in the 1970s. For 16 years after its discovery, even exploratory clinical studies with CoQ were extraordinarily restricted because there was so little of it available from organic sources. (CoQ is found in virtually all foods and human and animal tissues, but is difficult and costly to extract from these sources). This began to change in 1974 when the Japanese Nisshin began industrial production of CoQ from an ingredient in tobacco, which led to the production of hundreds of kilograms of the nutrient. This was used in clinical trials by the Eisai company, and was followed by the development of fermentation methods to synthesize CoQ in 1977 by the Kanegafuchi company, which also conducted clinical research. There also has been interest in Western countries, such as the determination of CoQ levels, for which English scientist Dr. Peter Mitchell was awarded the Nobel Prize.

### APPROVAL OF COQ IN JAPAN

These developments led to the approval (in the 1970s) of Coenzyme Q<sub>10</sub> in Japan (under the trade name **Ubidecarenono**) as a treatment for people with cardiovascular diseases. By 1982, CoQ had become one of the top 5 selling drugs in Japan, with about 6 million Japanese taking it on a regular basis. CoQ continues to be a top-selling drug in Japan. Its use there is primarily as a drug for

the treatment of specific conditions such as heart failure, cardiac arrhythmias, and hypertension (high blood pressure).

Although CoQ is highly effective in treating these diseases, its enormous potential as an anti-aging, anti-disease therapy has remained largely untapped because of the prevailing dogma in medical circles against the concept of an all purpose, health-building therapy and because of the bias in Western medicine that favors the development proprietary medicines that can be patented and protected against competition. Dr. Folkers pointed this out in 1986 in his acceptance speech, after being awarded the prestigious Priestly Medal for his research into CoQ and other nutrients by the American Chemical Society. "The reason CoQ is not a 'household nutrient' in the West," said Dr. Folkers, "has more to do with the lack of protected marketing positions, than its safety or how well it works."

### **THE FOUNDATION INTRODUCES COQ INTO THE U.S.**

The fact that CoQ is now sold openly as a nutrient in the U.S. is the direct result of an article ("Life Extension Benefits of Coenzyme Q10") by Gregory M. Fahy, Ph.D. in the July 1983 issue of The Life Extension Foundation's newsletter Anti-Aging News. This pioneering, "inside" article introduced CoQ into the United States. Its rundown of the voluminous scientific evidence (even then) that CoQ is essential for health and longevity was a revelation to Foundation members (and other Americans) who had never before heard of this remarkable nutrient.

More than half of Dr Fahy's article dealt with how readers might try to obtain CoQ and how if that proved impossible, they might raise their CoQ levels by supplementing their diet with the nutrient precursors of CoQ. At the time, the only source of CoQ in the U.S. was a Texas company that only offered small doses of CoQ at exceedingly high prices to select customers.

Another company in Maryland wanted to gain FDA approval in the U.S. as a cardiovascular drug, but hadn't yet raised enough capital to start clinical trials.

The primary worldwide sources of CoQ were the Japanese companies who had developed it, but they were primarily interested in seeing CoQ gain approval in the U.S. as a drug, as had been done Japan. None of them were especially interested in having CoQ sold as nutrient in this country because of their fear that the FDA would ban it as an "unapproved new drug".

### **DR. FAHY'S MEETINGS WITH JAPANESE COMPANY OFFICIALS**

The turning point came when Dr. Fahy set up several meetings with officials of the Japanese companies producing CoQ in an attempt to persuade them of the value of providing CoQ to companies who wished to sell it as a nutrient. Dr Fahy pointed out the enormous potential of CoQ as a disease-preventing, anti-aging therapy and tried to allay their fears about FDA intervention by focusing on the extraordinary safety of CoQ, which could be used, he suggested, to attempt to "persuade" the FDA from banning it. Since the Japanese were well aware of the safety of CoQ (because of the millions of consumers of CoQ in Japan) as well as its remarkable health benefits, they relented and decided to sell it to American companies.

Since then, the use of CoQ as a nutrient has grown by leaps and bounds in the United States. CoQ is now sold in health food stores around the country, and by many mail order companies. It is one of the most popular products sold through The Foundation and grows in popularity every year. We've introduced several CoQ products over the years, with the latest being Prolongevity's oil-based, soft-gel version of CoQ, which has shown greater bioavailability than dry versions of CoQ.

Although CoQ is now freely available in the U.S, the number of Americans enjoying the health benefits of CoQ is ridiculously small. Hundreds of research studies and clinical trials have demonstrated dozens of invaluable health and medical benefits for CoQ, with little or no toxicity reported, even at doses of hundreds of milligrams per day. The evidence *strongly* supports the proposition that *every* American could benefit from daily, supplemental CoQ, and that the regular, widespread use of this remarkable nutrient among Americans would save vast numbers of lives!

What follows is a rundown of the multiple health benefits of CoQ, based upon the latest published studies in the medical literature.

### **THE MULTIPLE HEALTH AND LONGEVITY BENEFITS OF COQ**

Among the documented health and longevity benefits of CoQ are the:

1. Generation of energy in every cell tissue, and organ of the body;
2. Prevention and treatment of a wide variety of cardiovascular diseases, including congestive heart failure, angina pectoris (heart pain), cardiac arrhythmias, high blood pressure, and atherosclerosis;
3. Prevention and treatment of cancer of the breast, lung, colon, prostate, and other types of cancer;
4. Treatment of several types of muscular dystrophy;
5. Treatment of periodontal disease;

6. Protection against ischemic damage from accidents and surgical procedures, especially in the heart;
7. Protection against the side effects of toxic drugs;
8. Protection against the cellular damage of excessive free radical activity;
9. Slowing of various aspects of the aging process leading to the extension of mean lifespan (in animal studies).

Now let's take a closer look at some exciting studies that document the extraordinary health benefits of coenzyme Q10.

## **HOW COENZYME Q<sub>10</sub> HELPS TO GENERATE ENERGY**

Your body is made up of 100 trillion or so cells, all of which must produce their own energy to carry out their essential life functions. In order to generate this energy your cells have factories (called mitochondria) where nutrients obtained from food are "burned" in the presence of oxygen obtained from the air we breath. An estimated 96% of the oxygen we consume is used solely for the generation of energy!

Coenzyme Q, is a necessary component of this energy-generating process in every cell of your body. No other substance can be substituted for CoQ, without which energy cannot be generated and life cannot be sustained! Here is how the process works:

The molecules in the food you eat are broken down into smaller units containing carbon atoms held together by negatively charged electrons. The bonds between the carbon atoms are then broken down further, so that the electrons are released. The energy built into these released electrons is converted in ATP, which the cells use as their energy currency. The depleted electrons are then charged protons and oxygen to form water-harmless waste product of the process.

### **COQ'S ROLE IN THE PROCESS**

CoQ molecules assist several enzymes that stimulate this energy-generating process by acting as a shuttle to transport both electrons and protons from one bioenergy enzyme to another. Each CoQ molecule carries electrons and protons from donor enzymes to acceptor enzymes. They then return to pick up more electrons and protons. The CoQ transport cycle is repeated over-and-over again, thousands of times a second! Every electron and proton from which energy is to be extracted must first be transported to that appropriate enzyme by a molecule of Coenzyme Q<sub>10</sub>

### **An Effective Therapy For Cardiovascular Disease**

The use of CoQ to prevent and treat cardiovascular diseases is the oldest and most documented health benefit provided by CoQ. There have been dozens of studies demonstrating that CoQ can protect the heart against damage from reduced blood flow and electrical disturbances, and that patients with heart pain, heart arrhythmias, congestive heart failure, heart valve problems, hypertension, and heart damage caused by toxic drugs such as adriamycin can be improved significantly in some cases dramatically by treatment with CoQ.

A number of proposed therapeutic mechanisms of action for CoQ in cardiovascular disease can be found in TABLE 1. However there's little doubt that the basic, underlying mechanism of action for CoQ's cardiovascular benefits is its role in the generation of energy. Animal hearts pretreated with CoQ show substantially less depletion of ATP than untreated hearts. Ultrastructural studies show that hearts pretreated with CoQ maintain mitochondrial architecture within their cells far better than untreated control hearts, and that CoQ stabilizes and strengthens heart cell membranes, improves the heart's mechanical performance, protects the heart against free radical damage, and keeps heart cells alive (in tissue culture) far longer than untreated cells.

### **CLINICAL HEART FAILURES STUDIES WITH COQ**

The rationale for using CoQ in the treatment of patients with congestive heart failure comes from studies showing that blood and tissue levels of CoQ in more than 1,000 heart attack patients were significantly lower than normal. In one study it was shown that the most favorable clinical response to CoQ was in patients with the lowest blood levels of CoQ.

There have been more than 31 reports of clinical trials in Japan describing the favorable effects of either intravenous or oral CoQ therapy in patients with heart failure from various causes. Some of these trials used CoQ by itself, in others CoQ was used in addition to conventional therapies such as digitalis, diuretics, and vasodilators.

In one controlled trial, 12 patients who failed to get relief from diuretics and digitalis were given 100 mg daily of oral CoQ. After 30 days, 67% of the patients showed clinical improvement in their symptoms, including dyspnea (breathing problems) and fatigue. There was also a significant reduction in left atrial size, an indication of improved heart performance.

In a placebo-controlled, double blind, crossover trial, 19 patients with advanced heart failure were treated with 33 mg of CoQ three

times a day for 12 weeks. The result showed significant improvement in cardiac function during CoQ treatment as compared to controls in such functions as ejection fraction, stroke volume, and contractibility.

Although the results of these trials are highly persuasive, they were all relatively small in size. In the last few years, however, the results of a large multicenter trial of CoQ in heart failure patients in Italy have been published in several journals.

**Table 1**

**Possible Therapeutic Mechanisms of Coenzyme Q<sub>10</sub> Cardiovascular Disease**

1. Correction of CoQ deficiency state.
2. Direct free radical scavenger via semiquinone species.
3. Direct membrane stabilizing activity due to phospholipid protein interactions.
4. Correction of mitochondrial "leak" of electrons during oxidative respiration.
5. Induction of DT diaphorase.
6. Possible effects on prostaglandin metabolism.
7. Inhibition of intracellular phospholipases.
8. Preservation of myocardial Na<sup>+</sup>- K<sup>+</sup> ATPase activity.
9. Stabilization of integrity of Ca<sup>+2</sup> dependent slow channels.

**ITALIAN MULTICENTER STUDY**

The Italian study looked at CoQ as an adjunct to conventional drugs in 2,664 heart patients in 173 clinical centers over a 3-month period. The daily dosage of CoQ was 50-150 mg daily with the majority of patients (78%) receiving 100 mg/day. The patients in the study were all rated Class II and III (moderately ill) according to a rating scale based upon the guidelines formulated by the New York Heart Association (NYHA) regarding the symptoms associated with congestive heart failure.

The results showed improvement in virtually all functions measured in the CoQ-treated patients. The proportions of patients exhibiting significant improvement (of at least one point) in clinical symptoms was as follows (Tables 2 and 3): cyanosis 78.1%, edema 78.6%, pulmonary rate 77.8%, enlargement of liver 49.3%, jugular reflex 71.8%, dyspnoea 52.7%, palpitations 75.4%, sweating 79.8%, arrhythmias 63.4%, insomnia 66.8%, and vertigo 73.1%. They also found significant improvement in at least three symptoms in 54% of the patients, indicating major improvement in the quality of their lives.

The investigators summed up their results as follows:

"A significant reduction in blood pressure and heart rate, both in supine and sitting position, was observed in our study. These data confirm the results of a recent study in which CoQ<sub>10</sub> therapy led to a reduction in peripheral vascular resistance, resulting in a significant decrease in blood pressure. An inhibitory effect of CoQ<sub>10</sub> on plasma catecholamine levels in heart failure has been recently reported. In our patients, the reduction in peripheral vascular resistance may be related to an inhibition by CoQ<sub>10</sub> of the sympathetic overactivity known to be present early in heart failure. The reduction in sweating and palpitations, reported by our patients may result from the same mechanism."

**Table 2**

**CLINICAL SIGNS ASSESSMENT RESULTS**

Description	Present at baseline(n)	Improved at least 1 point after 3 months of CoQ <sub>10</sub> treatment (%)	Statistical significance of score variations*
Cyanosis	675	78.67	P<0.01
Odema	1764	78.06	P<0.01
Pulmonary Rates	1752	77.85	P<0.01

Enlargement of liver area	1285	49.26	P<0.01
Jugular reflux	713	71.81	P<0.01

\* Wilcoxon signed-rank

**Table 3**

Clinical Symptoms Assessment Results

Description	Present at baseline(n)	Improved at least 1 point after 3 months of CoQ <sub>10</sub> treatment (%)	Statistical significance of score variations*
Dyspnoea	2163	52.75	P<0.01
Palpitations	1903	75.46	P<0.01
Sweating	1044	79.79	P<0.01
Subjective arrhythmia	1143	63.43	P<0.01
Insomnia	1597	62.87	P<0.01
Dizziness	1282	73.13	P<0.01
Nocturia	1541	53.67	P<0.01

\* Wilcoxon signed-rank

**TREATMENT OF HYPERTENSION WITH COQ**

We've been recommending CoQ to patients with cardiovascular disease for years with very good results. Most of these patients start taking CoQ in addition to the conventional drugs they are using. In many cases, they find that prolonged use of CoQ eliminates their need for such prescription drugs, A recent study of the use of CoQ in patients suffering from hypertension (high blood pressure) showed how CoQ can' help patients dispense with their drugs.

This study was conducted by scientists (including Karl Folkers) at the University of Texas at Austin. A total of 109 patients with hypertension were given a variable dose of from 75 to 360 mg/day of CoQ in addition to the existing drug regimen. The patients were followed closely with frequent clinic visits to record blood pressure and make the necessary adjustments in dosage. No side effects or drug interactions were found in any of the patients in the study.

**FIGURE 3**

They found that mean systolic blood pressure improved from 159 to 147 and mean diastolic blood pressure improved from 94 to 85 (Figure 3). They also found that, as the patients' functional status and blood pressure improved, and there was a gradual decrease in the need for antihypertensive drugs. Thirty-seven percent of the patients were able to discontinue one drug, 11% discontinued two drugs, and 4% discontinued three drugs. The average time before stopping an anti-hypertensive drug was 4.4 months after starting CoQ, with 62% requiring 3 or more months (Figure 4).

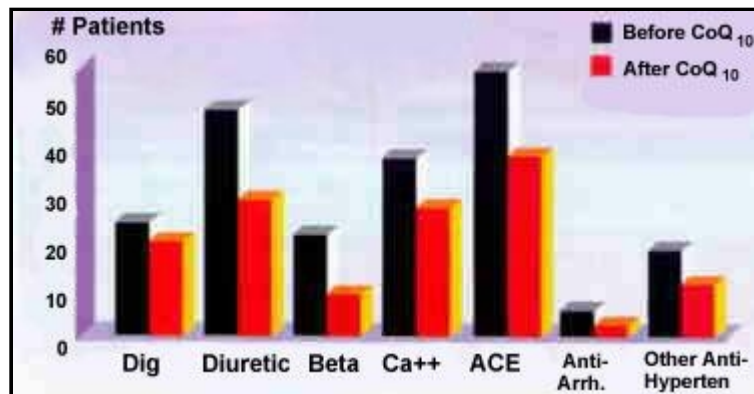
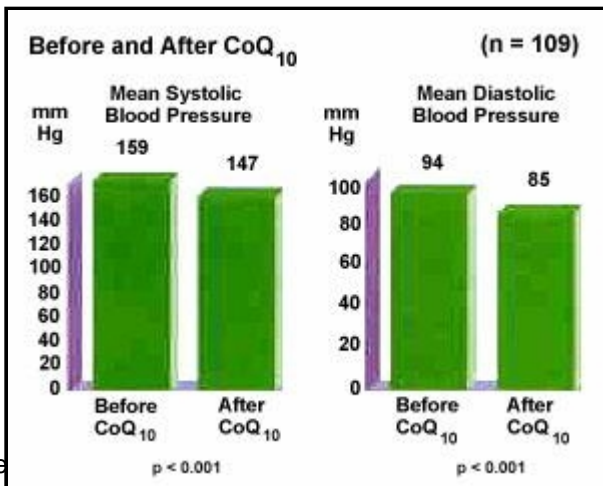


Figure 4

They conclude that:

"CoQ, a both remarkably safe and cost effective and should be considered among the initial therapeutic modalities alongside such fundamental recommendations as diet exercise and stress reduction and should certainly be considered prior to embarking upon an escalating course of pharmacologic interventions with all of their well established medical and economic hazards."



Interestingly, the Texas scientists found that the most effective way of raising blood levels of CoQ in patients was to give it with a fat containing food (usually peanut butter), which "more than doubled the blood CoQ level on any given dosage." This is not surprising because CoQ is a fat-soluble nutrient that assimilates better in the presence of fat. For this reason, The Foundation now offers CoQ in oil-based, soft-gel capsules, which maximizes its bioavailability within the body.

### THE BIOAVAILABILITY OF COQ

Recent studies at the Royal Danish School of Pharmacy in Denmark have demonstrated that "CoQ in soy bean oil in soft gelatine capsules has higher bioavailability than CoQ formulated with other inert substances." These studies compared CoQ in dry powder form (in capsules) and in tablets with various oil-based formulations of CoQ. It is on the basis of these studies that we now offer CoQ in the same soy-bean-oil formula shown in these studies to produce optimal absorption of CoQ into the body. For further information about this product, call 1-800-64414440 or you can order CoQ10 On-line.

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