L-Carnitine and Coenzyme Q₁₀
Supporting Heart Health
Key Role: Energizing the Body

The body uses carbohydrate, fat and protein consumed daily in food to provide the energy necessary to maintain cellular activities at rest and during exercise. The biochemical and metabolic roles of L-Carnitine and CoQ10 are closely related and involve facilitating energy production in the body.

L-Carnitine plays a fundamental part in ensuring the production of energy from fat. Fatty acid breakdown (β-oxidation) and subsequent energy production occur inside the mitochondria of the human cell. In order to produce energy from fat, long chain fatty acids need to move into the mitochondria. However, the mitochondrial membrane acts as a barrier to long chain fatty acids, refusing permission to enter. This is where L-Carnitine comes into play. L-Carnitine binds to the long chain fatty acids and through a series of enzymatic steps, it “shuttles” the fatty acids into the mitochondria where they can be subsequently broken down and energy can be produced in the form of adenosine triphosphate, ATP. Thus, to reiterate, L-Carnitine facilitates the production of energy from fat.

Take Note! L-Carnitine and CoQ10 both have a vital interrelated role in producing energy in the body: L-Carnitine delivers the fuel (fatty acids) and CoQ10 helps to make sure energy (ATP), essential for life, is subsequently produced.
CoQ10 also has a critical function in the energy-producing process in the body. In humans, the aerobic (meaning in presence of oxygen) production of ATP occurs inside the mitochondria and this process may conveniently be broken into three stages. Stage 1 is the generation of Acetyl-CoA from the products of protein, carbohydrate and fat breakdown, i.e., amino acids, pyruvate and fatty acids, respectively. Stage 2 is Krebs cycle where the Acetyl CoA is broken down and finally, Stage 3 is the process of oxidative phosphorylation (i.e., ATP or energy formation) in the electron transport chain (Figure 1). CoQ10 acts as an electron carrier in the mitochondrial electron transport chain and thereby plays a critical role in energy production in the body. Circumstances which change the quantity of CoQ10 in the inner mitochondrial membrane correspondingly change the electron transport rate, thus influencing the efficacy of energy production6.

L-Carnitine and CoQ10:
Supporting Cardiovascular Health

Following decades of clinical research, L-Carnitine and CoQ10 are both individually recognized as key supplements for supporting cardiovascular health. The heart actually depends upon L-Carnitine for most of its energy production because the majority of the heart’s energy supply comes from the breakdown of fat7. Recall that L-Carnitine’s role in the body is in ensuring the production of energy from fat.

A brief insight into cardiovascular disease may be helpful before further discussion. Similar to any other tissue, the heart muscle must receive oxygen-rich blood in order to function efficiently. The coronary arteries are the blood vessels responsible for supplying this blood to the heart muscle. Coronary artery disease is a condition in which fatty deposits accumulate in the walls of the coronary arteries and obstruct blood flow to the heart muscle. As the obstruction gets bigger, it causes inadequate blood flow (ischemia) to the heart muscle and this, in turn, can cause heart damage. Coronary artery disease can ultimately lead to angina, a heart attack and heart failure8.

Although L-Carnitine and CoQ10 are typically marketed as dietary supplements and the U.S. Food and Drug Administration therefore restricts claims to those associated with supporting a healthy cardiovascular system, studies conducted on L-Carnitine’s and CoQ10’s role in the management of cardiovascular conditions provide substantiation in support of dietary supplement claims. Discussions of these studies are solely intended to describe the substantiation underlying dietary supplement claims and are not intended to state or imply an intended use of L-Carnitine and CoQ10 dietary supplement products for these conditions. Consultation with a healthcare practitioner is advisable for individuals with these conditions to determine which products are appropriate.

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Figure 1: Aerobic Production of Energy. Note the essential involvement of L-Carnitine and Coenzyme Q10 in this process. (Adapted from reference 5.)
L-Carnitine, CoQ10 and Angina

Angina is the temporary chest pain that occurs while the heart muscle is not receiving enough oxygen (via the blood). Usually, angina is caused by coronary artery disease. In stable angina, individuals have episodes of chest pain that are predictable and usually occur on physical exertion or under mental or emotional stress. In stable angina, the ability to exercise is usually diminished because of the onset of chest pain. Complications include the development of unstable angina, a heart attack or fatal irregular heart rhythms. In 2001, it was estimated that almost 7 million Americans had angina.

Clinical Research Findings in Support of Dietary Supplement Claims

Numerous clinical studies document the positive effects of L-Carnitine in people with stable angina. In one study, 200 people with stable angina were divided into a control group and an L-Carnitine group who were supplemented with 2g L-Carnitine/day for 6 months, in addition to their routine drug treatment. Supplementation with L-Carnitine was associated with significantly improved exercise tolerance, improved heart function and performance, reduced need for cardioactive drugs and significantly improved blood lipid (cholesterol and triglyceride) levels.

A number of small clinical studies also suggest that CoQ10 supplementation can be beneficial for people with stable angina. In one study, 12 people with stable angina were given CoQ10 (150 mg/day) or placebo for 4 weeks in a double-blind, placebo-controlled, crossover study. CoQ10 supplementation was associated with a significant increase in exercise tolerance, as well as reduced incidence of anginal attacks and need for angina-relieving medication.

L-Carnitine, CoQ10 and Heart Attack (Myocardial Infarction)

A heart attack occurs when the blood supply to part of the heart muscle is severely reduced or completely cut-off, usually as a result of the build-up of fat deposits in the coronary arteries. If the blood supply to the heart muscle is cut-off for more than a few minutes, muscle cells suffer permanent injury and die. The extent of heart muscle damage dictates the overall outcome for the person having the heart attack. If more than half of the heart muscle is damaged, the heart generally cannot function and death or disability is likely. In 2004, it is estimated that 700,000 Americans will have a new heart attack, while a further 500,000 will have a recurrent attack.

Clinical Research Findings in Support of Dietary Supplement Claims

L-Carnitine supplementation has been shown to be beneficial in supporting heart function in people who have had a recent heart attack. In a 12 month study, 160 people who had a recent heart attack were divided into two groups: a control group (routine pharmacological therapy) and an L-Carnitine group (routine pharmacological therapy plus 4g L-Carnitine/day). It was observed that L-Carnitine exerted cardioprotective effects by improving heart rate, decreasing complications (such as angina and arrhythmias) and most importantly, by significantly reducing the rate of mortality. In addition to reducing complications such as angina and irregular heartbeats, supplementing with L-Carnitine (2g/day for 28 days) following a recent heart attack may be protective by reducing the extent of damage to the heart muscle.

![Figure 2: Rate of mortality in post-heart attack subjects following treatment with L-Carnitine (4g/day for 12 months)](image-url)
Preliminary clinical research indicates that CoQ10 supplementation positively supports heart function in people who have had a recent heart attack. In a double-blind, placebo-controlled study, 144 people who had a very recent heart attack were assigned to either a CoQ10 group (120 mg/day for 28 days) or a placebo (B vitamin) group. Routine pharmacological therapy was also taken by both groups. After 28 days, angina, irregular heartbeats and signs of cardiac dysfunction were significantly reduced in the CoQ10 group, as compared to the placebo group. In addition, indicators of free radical stress and cell damage due to the heart attack were significantly reduced in the CoQ10 group, while plasma levels of the antioxidant vitamins A, E, C and beta-carotene were significantly elevated. At the 1 year follow-up, it was reported that plasma levels of Vitamin E and C were significantly elevated in the CoQ10 group, while markers of free radical stress and cell damage were significantly reduced. Subjects given CoQ10 also showed a significant reduction in total and LDL-cholesterol and a significant increase in HDL-cholesterol (the “healthy” cholesterol). Total cardiac events were significantly reduced in the CoQ10 group (24.6%) as compared to the placebo group (45.0%).

L-Carnitine, CoQ10 and Heart Failure

Heart failure is a serious condition in which the quantity of blood pumped by the heart each minute is insufficient to meet the body’s needs for oxygen and nutrients. As a result, people with heart failure tend to feel weak, fatigued or short of breath. The most common cause is coronary artery disease. Other causes include a previous heart attack, high blood pressure, diabetes and heart muscle disease (cardiomyopathy). The New York Heart Association (NYHA) Functional Classification places people with heart failure in categories I through IV depending upon how limited they are during physical activity. Class I indicates the mildest, and class IV the most severe, form of heart failure. In 2001, about 5 million Americans were living with heart failure. About 70% of people with heart failure die of the disease within 10 years.

Clinical Research Findings in Support of Dietary Supplement Claims

Clinical research has found that L-Carnitine supplementation is of benefit to people with heart failure by supporting heart function and reducing some of the symptoms experienced. In a placebo-controlled, randomized, double-blind trial, L-Carnitine supplementation (3g/day for 120 days), in addition to routine pharmacological therapy, was found to significantly improve exercise tolerance and performance in individuals with NYHA Class II and III heart failure. The beneficial effect of the L-Carnitine increased with the duration of supplementation. In a long term clinical study, people with NYHA Class III or IV heart failure were given L-Carnitine (2g/day) or placebo for almost 3 years. The results are exciting in that the researchers reported a significant reduction in mortality rate in the L-Carnitine group (3%) versus the placebo group (18%) who were given standard therapy only.

Many double-blind, placebo-controlled, crossover studies, as well as open trials and large multicenter trials have looked at the effect of CoQ10 in people with heart failure and the majority of these studies indicate that CoQ10 supplementation, in addition to conventional drug therapy, positively supports heart function in cardiomyopathy and heart failure. In a double-blind, placebo-controlled, crossover trial, 19 people with cardiomyopathy (NYHA Class III or IV) were given placebo or CoQ10 (100 mg/day) for 12 weeks, in addition to conventional therapy. A significant improvement in cardiac function occurred with CoQ10 supplementation. In an open, long-term trial, the effect of CoQ10 supplementation (average 242 mg/day for an average of 17.8 months) was studied in 424 people with heart failure due to various causes. Supplementation was associated with clinical improvement as assessed by NYHA class. A significant improvement in cardiac function, as well as reduced requirement for cardiac medications. It was concluded that CoQ10 is a safe and effective adjunctive treatment for a broad range of cardiovascular diseases.
levels of Vitamin E in post-heart attack subjects supplemented with CoQ10 may be attributed to the established antioxidant and Vitamin E-sparing properties of CoQ10. In the case of heart failure and cardiomyopathy, CoQ10 supplementation is thought to correct the observed deficiency of CoQ10 in the heart, resulting in improved energy production which supports cardiac function.

Combining L-Carnitine and CoQ10 to Support Heart Health

Clearly, on an individual basis, L-Carnitine and CoQ10 have an important role to play in supporting and maintaining heart health. Both have inter-related functions in energy production in the body. On this basis, it seems reasonable to suggest that combining L-Carnitine with CoQ10 for supporting heart health might have an additive protective effect for the heart. Animal studies have documented the cardioprotective benefits of combining L-Carnitine and CoQ10. Notably, in rats fed a high cholesterol diet for 6 weeks, the incidence of atherosclerosis (build up of fatty deposits in arteries which leads to heart disease) was lower when the rats had both CoQ10 and L-Carnitine added to the diet.

Take Note! In the US, L-Carnitine and CoQ10 are available as standalone dietary supplement products or as combination products containing both L-Carnitine and CoQ10. Lonza, the leading supplier of L-Carnitine to the dietary supplement industry, is pleased to provide high quality L-CARNIPURE® L-Carnitine to dietary supplement manufacturers wishing to produce energizing and heart healthy L-Carnitine and CoQ10 combination products.

Supplementation, Safety and Side Effects

L-Carnitine and CoQ10 supplementation may be advisable for people concerned with maintaining everyday energy levels and supporting a healthy heart. Although symptoms of heart disease may not start to appear until middle age or older, scientists have found that heart disease begins developing well before this. Therefore, making good lifestyle changes, such as eating a heart-healthy diet, getting regular exercise, and maintaining a healthy weight, can help reduce the risk of heart disease.
choices such as eating healthy foods and exercising regularly is important earlier in life. Taking L-Carnitine and CoQ10 may offer further cardioprotection. It is also worth noting that as we age, the levels of both L-Carnitine and CoQ10 decrease in the body. More than ever, at this time in the life cycle, maintaining energy levels and heart health is essential for good quality of life.

Based on the numerous clinical studies conducted to date, it appears that both L-Carnitine and CoQ10 are very safe with few side effects reported. **Scientific literature has documented an interaction between CoQ10 and certain drugs, making consultation with a physician advisable before supplementation.**

**Lonza – The Leader in L-Carnitine**

Lonza is the world's leading supplier of pharmaceutical grade L-CARNIPURE® L-Carnitine bulk products to the dietary supplement, pharmaceutical and infant formula industries.

Lonza’s L-CARNIPURE® L-Carnitine products include:
- **L-Carnitine Crystalline**
- **L-Carnitine L-Tartrate** (US patent 5,073,376, Japanese patent 2,546,068 and other international patents)
- **L-Carnitine Magnesium Citrate** (US patent 5,071,874 and other international patents)
- **Acetyl-L-Carnitine**

L-CARNIPURE® L-Carnitine L-Tartrate is the most popular form of L-Carnitine in the marketplace. This white, crystalline, free-flowing, non-hygroscopic form of L-Carnitine is ideally suited for tablets and capsules (both hard-shell and soft-gel), as well as liquid applications. Of all stable L-Carnitine salts commercially available, L-Carnitine L-Tartrate has the highest content of L-Carnitine (68%), with 32% natural L-Tartaric Acid. L-CARNIPURE® L-Carnitine L-Tartrate and L-Carnitine Crystalline are Generally Recognized as Safe and are Kosher and OU certified.

With quality assurance of utmost importance, Lonza’s L-CARNIPURE® L-Carnitine products are:
- manufactured using a unique patented production process
- produced in a state-of-the-art, FDA registered and ISO 9001.2000 certified plant
- manufactured in compliance with current Good Manufacturing Practice
- free from animal products and genetically modified organisms (GMOs)
- free from any harmful D-Carnitine, hence the quality assurance logo, L-CARNIPURE®.


**References**

39. Amer. Heart J. 139:S120.