The Awesome Foursome
Coenzyme Q10, L-Carnitine, D-Ribose, Magnesium

by totalhealth editors

The “Awesome Foursome” of Coenzyme Q10, L-Carnitine, D-Ribose, and Magnesium helps our hearts metabolize energy more efficiently and protects them from the stress of cardiovascular disease. This powerful combination of nutrients goes directly to the basic biochemistry of cellular energy metabolism. Now let’s take a closer look at how Coenzyme Q10, L-carnitine, D-Ribose, and magnesium work in synergy to promote cardiovascular health.

Coenzyme Q10:
Energy Recycling through the Electron Transport Chain

Coenzyme Q10 is a powerful antioxidant that helps protect the mitochondrial membrane, mitochondrial DNA, and cell walls from free-radical attack. But its most important function in the body is its central role in energy metabolism.

Most—about 90 percent—of the ATP used by cells is recycled as food (fuel) and oxidized in the mitochondria. Fatty acids, carbohydrates, and, occasionally, proteins are carried across the mitochondrial membrane and enter the Krebs’ cycle, moving from step to step and spinning off electrons. These electrons are then handed off to the electron transport chain, where, in the presence of oxygen, the energy from the electrons is captured as a phosphate group is added to ADP to form ATP. This recycling of ATP is called oxidative phosphorylation, and the by-products of these pathways are CO2 and water.

In this fashion, Coenzyme Q10 acts as a gatekeeper of electrons, making sure they are carried to just the right place to pass on their life-giving energy.

What is critical, however, is the simple fact that without Coenzyme Q10 the electron transport chain would totally breakdown. And since the electron transport chain is (by far!) the largest contributor to cellular energy turnover, its loss would be catastrophic. It is also important to know that there has to be an excess of Coenzyme Q10 in the mitochondria to be maximally effective. Having just enough isn’t sufficient to do the job properly, and having a deficiency seriously affects the mitochondria’s ability to supply the cell with energy.

Cellular stress can cause Coenzyme Q10 deficiency, which places a severe strain on Coenzyme Q10 availability. People with heart disease, hypertension, gingival disease, Parkinson’s disease, and other disorders are known to be deficient in Coenzyme Q10. Whether these deficiencies are the cause or the effect of these varied medical problems, the end result is that they sap the life out of their mitochondria and reduce their energy supplies. You see, Coenzyme Q10 cannot function properly if electrons are not coming out of the Krebs’ cycle, and the Krebs’ cycle won’t work without the fuel that’s transported into the mitochondria by L-carnitine.
L-Carnitine: Transporting the Cellular Energy Fuel

Fatty acids are the preferred energy fuel for hearts and most other cells in the body. L-carnitine facilitates the beta oxidation of fatty acids as energy fuel. And since fatty acids are the preferred fuel for energy recycling in cells, this action is critical to cell and tissue function. Unfortunately, L-carnitine is deficient in people with heart disease, peripheral vascular disease, lipid metabolic disorders, mitochondrial disorders, and many other disease syndromes. This L-carnitine deficiency disrupts the normal metabolism of fatty acids, reducing available energy supplies and leading to the accumulation of toxic by-products of fatty acid metabolism. L-carnitine supplementation revives fatty acid metabolism and restores normal mitochondrial function. But even this powerful improvement in cellular energy metabolism cannot make up for the energy drain that comes from the loss of energy substrates caused by low oxygen delivery to the tissue. Only D-Ribose can do that.

D-Ribose: Rebuilding the Cellular Energy Pool

As long as cells and tissues have plenty of oxygen, the pool of energy substrates in the cell remains high. And as long as there is enough L-carnitine and Coenzyme Q10 available, the process of energy utilization and supply can proceed unimpeded. However, the cellular supply of oxygen can be restricted by acute or chronic heart disease, peripheral vascular disease, any number of skeletal- or neuromuscular diseases, or even high-intensity exercise.

When cells are deprived of oxygen the mitochondrial energy turnover becomes inefficient. Remember, oxygen is required to let the oxidative pathway of energy recycling work properly. If the mitochondria are not able to recycle energy efficiently, cellular energy supply cannot keep pace with demand. But the cell has a continuing need for energy, so it will use all its ATP stores and then breakdown the by-product, adenosine diphosphate (ADP), to pull the remaining energy out of this compound as well. What’s left is adenosine monophosphate (AMP). Since a growing concentration of AMP is incompatible with sustained cellular function it’s quickly broken apart and the by-products are washed out of the cell. The net result of this process is a depletion of the cellular pool of energy substrates. When the by-products of AMP catabolism are washed out of the cell, they are lost forever. It takes a long time to replace these lost energy substrates even if the cell is fully perfused with oxygen again.

Ribose is the only compound used by the body to refill this energy pool. Every cell in the body has the capacity to make ribose, but hearts, muscles, and most other tissues lack the metabolic machinery to make Ribose quickly when the cells are stressed by oxygen depletion or metabolic insufficiency. Ribose is made naturally in the cells from glucose. In stressed cells, however, glucose is preferentially metabolized for energy turnover and is not available for ribose synthesis. So when energy pools are drained from stressed cells, the cells must first wait for the slow process of Ribose synthesis before they can begin to replace their lost energy stores.

Acute ischemia, like that which takes place during a heart attack, heart surgery, or angioplasty, drains the cell of energy. Even when oxygenated blood flow returns, refilling the energy pool may take ten or more days. But when oxygen deprivation is chronic, or when energy metabolism is disrupted by disease, there may be so much continual strain on the energy supply that the pool can never refill without the assistance of supplemental Ribose. Conditions like ischemic heart disease or congestive heart failure fall into this category. In these situations, supplementing the tissue with exogenous Ribose is the only way the cell can keep up with the energy drain.
Magnesium: Switching on the Energy Enzymes

Magnesium is an essential mineral that's critical for energy requiring processes, in protein synthesis, membrane integrity, nervous tissue conduction, neuromuscular excitation, muscle contraction, hormone secretion, maintenance of vascular tone, and in intermediary metabolism. Deficiency may lead to changes in neuromuscular, cardiovascular, immune, and hormonal function; impaired energy metabolism; and reduced capacity for physical work. Magnesium deficiency is now considered to contribute to many diseases, and the role for magnesium as a therapeutic agent is expanding.

Magnesium deficiency reduces the activity of important enzymes used in energy metabolism. Unless we have adequate levels of magnesium in our cells, the cellular processes of energy metabolism cannot function. Small changes in magnesium levels can have a substantial effect on heart and blood vessel function. While magnesium is found in most foods—particularly vegetables—deficiencies are increasing. Softened water and a trend toward lower vegetable consumption are the culprits contributing to these rising deficiencies.

Supporting The Links In The Energy Cycle Chain—the Synergy

Clearly, each member of the “Awesome Foursome” is fundamental to cellular energy metabolism in its own right. Each plays a unique and vital role in supplying the heart with the energy it needs to preserve its contractile force. Each is independently effective in helping hearts work through the stress of disease. And while each contributes immeasurably to the energy health of the cell, in combination they are unbeatable. Allow me to reiterate the step-by-step, complicated cellular processes involved to be sure that you really understand the rationale for using these nutrients.

The cell needs a large, sustained, and healthy pool of energy to fuel all its metabolic functions. Contraction, relaxation, maintenance of cellular ion balance, and synthesis of macromolecules, like proteins, all require a high energy charge to carry their reactions to completion. The energy pool must be preserved, or these fundamental cellular functions will become inefficient or will cease to operate altogether. To keep the pool vibrant and healthy, the cell needs Ribose. But even with supplemental Ribose, the cell needs the efficient turnover of its energy stores to balance ongoing energy utilization with supply. That's where CoQ10 and L-carnitine come into play.

The converse is also true. Even if the cell is fully charged with energy, cellular energy supply will not keep pace with demand if the mitochondria are not functioning properly. CoQ10 and L-carnitine work to keep mitochondrial operations running at peak efficiency, and one side cannot work effectively without the other. Even though CoQ10 and L-carnitine can make the energy turnover mechanisms work more efficiently, they cannot increase the cell's chemical driving force, and their action will be only partially effective. Ribose, on the other hand, can keep the energy pool supplied with substrate, but the value of energy pool repletion cannot be fully realized if the substrate cannot be maximally utilized and recycled. Ribose fills the tank; CoQ10 and L-carnitine help the engine run properly.

Magnesium is the glue that holds energy metabolism together. By turning on the enzymes that drive the metabolic reactions, magnesium allows it all to happen.

These four nutrients must be utilized by cardiologists and other physicians as they treat patients day-to-day. On my own journey, using Coenzyme Q10 for two decades, L-carnitine for more than ten years, D-Ribose for two years, and magnesium equally as long, I've seen this “Awesome Foursome” reduce suffering and improve the quality of life for thousands of patients.
The future of nutrition in conventional medicine is very bright, although the integration of nutritional supplements has been a slow and, at times, lonely process.

L-carnitine and Coenzyme Q10 are finally gaining the recognition they deserve. D-Ribose is emerging as a new player in the complex understanding of metabolic cardiology, and doctors are beginning to discuss the important role of magnesium deficiency in heart patients. As a practicing cardiologist for over thirty years, I see metabolic cardiology as the future for the treatment of heart disease and other complex disease conditions, as well.