Reverse Mitochondrial Damage
Potent Molecular Energizers for Lifelong Health

By Julius Goepp, MD

Potent Endothelial Defense

The lining of our blood vessels, or endothelium, regulates blood flow and pressure, and is easily damaged by oxidative stress and inflammation, which increases the risk of atherosclerosis and erectile dysfunction. CoQ10 powerfully protects endothelial function, an effect that is likely due to its uniquely beneficial effect on mitochondrial function.37

One study of the ubiquinol form of CoQ10 showed that it protects against hypertension, improves endothelial function, and reduces cardiac enlargement in stroke-prone rats.38 When humans with endothelial dysfunction took 300 mg/day of CoQ10 orally for one month, their blood vessels relaxed more readily and they moved more oxygenated blood into tissues compared with placebo recipients.39

People with type 2 diabetes are at particularly high risk for endothelial dysfunction, and have more heart attacks and strokes as a result.40 CoQ10 supplementation is especially effective at improving endothelial function in this population.41 Diabetics (and others) often need to take statin-type lipid-lowering medications to control their cholesterol levels. Unfortunately, these drugs (also known as HMG Co A reductase inhibitors) are known to deplete CoQ10 and can cause muscle pain that may be related to this depletion.42 CoQ10 overcomes this problem and has been shown to improve endothelial function in diabetic patients on statins.43

Muscular Energy Enhancement

Exercise can boost longevity and even increase mitochondrial density in the short term; however, exercise can also damage the mitochondria in the long term.44,45 The high rate of oxygen and electron flow that exercise requires can lead to chronically low ATP levels, which may exert negative effects during vigorous exercise.46 CoQ10 supplementation can counteract such effects, enhancing the adaptive response of skeletal muscle following exercise.47

CoQ10 supplementation before exercise increases muscle CoQ10 levels, reduces muscular oxidant stress, and may increase the amount of time you can exercise until exhaustion.48 To take one dramatic example, CoQ10 supplementation of 300 mg/day resulted in improved blood markers of exercise-induced muscle injury among elite Japanese Kendo athletes (a form of martial arts) practicing up to five-and-a-half hours per day.49

CoQ10 at just 100 mg/day even enhances performance of normally sedentary men during repeated bouts of exercising.50 Supplementation of 300 mg/day enabled adults to increase their velocity on a stationary bike compared with placebo, while reducing fatigue.51

CoQ10’s remarkable energy-boosting effects can also reduce adverse effects associated with statin therapy, including fatigue, muscle pain, shortness of breath, memory loss, and nerve pain in the extremities.52 Patients with statin-induced fatigue who stopped the drug and took 240 mg/day of CoQ10 saw a decrease in fatigue from 84% to just 15%; a drop in muscle pain from 64% to 6%, and a decline in shortness of breath from 58% to 12%. These are all manifestations of restored mitochondrial energy and function—and the study found no adverse consequences from discontinuing the statin drugs. (You should never abruptly discontinue any medication without discussing it with your doctor.)

System-Wide Protection

CoQ10 also has dramatic benefits in other tissues, particularly in the brain, eyes, and skin.
There’s growing recognition of the role of “brain energetics,” including mitochondrial health, in causing (or preventing) progressively fatal neurological conditions, including Alzheimer’s disease, Parkinson’s disease, and amyotrophic lateral sclerosis (ALS or Lou Gehrig’s Disease). Animal studies show that CoQ10 supplementation increases brain levels of CoQ10, sustaining the brain’s tremendous energy needs. At the same time it reduces brain injury and increases life span in mice with a neurodegenerative disease similar to ALS.

CoQ10 benefits peripheral nerves as well. People with diabetes often succumb to painful diabetic neuropathy and decreased ability to sense pressure, which can lead to disastrous injuries. Studies of diabetic rats with neuropathy show that CoQ10 improved nerve conduction velocity and strength of nerve impulses.

Nerve cells in the eye are faced with enormous energy demands—they must convert light into electrical impulses, while protecting themselves from the damaging effects of both. Researchers now know that mitochondrial health is vital to sustaining the health of cells in the retina, where optical nerves are concentrated. Unfortunately, CoQ10 levels in the retina decline rapidly with age, leaving delicate cells vulnerable.

In combination with acetyl-L-carnitine and omega-3 fatty acids, CoQ10 generated dramatic results in studies of individuals suffering from early age-related macular degeneration. Supplemented patients had a 10-fold lower risk of worsening over a 12-month period, compared with those who received placebo. Pre-clinical models suggest that CoQ10 may even protect retinal tissue from the effects of glaucoma.

Our skin shows the most immediate and visible signs of aging. Only recently have we learned how much this has to do with mitochondrial dysfunction in skin cells: skin biopsies from older people show substantially less mitochondrial function than those from younger people.

Increased oxidative damage from diminished mitochondrial function has been shown to trigger inflammation and launch protein-destroying enzymes into action. Over time this leads to a weakening of the delicate matrix of skin tissue, spots, wrinkles, dryness—even cancer. Many studies show that topical CoQ10 treatment inhibits inflammatory cytokines, reduces wrinkling enzyme production, and improves the appearance and radiation-resistance of older skin. Boosting CoQ10 through oral supplementation also affords vital protection.

### ADVANCED MITOCHONDRIAL THREATS: GLYCATION AND LIPOXIDATION

The chemical reaction of glucose with proteins and fats that occurs over a lifetime produces advanced glycation end-products (AGEs) and advanced lipoxidation end-products (ALEs). These deadly molecules cause oxidative and inflammatory damage to mitochondria, hastening mitochondrial dysfunction and aging. Specific compounds have been shown to provide targeted mitochondrial defense against glycation and the inflammation it produces.

- **Carnosine** is a nutrient comprised of two amino acids. It’s a natural antioxidant and anti-glycation molecule proven to reduce reactive oxygen and nitrogen species resulting from chronic glucose exposure, while also binding to potentially dangerous metal ions (chelation). These features make it attractive as an anti-aging, anti-Alzheimer’s agent.
- **Luteolin** is a flavonoid with potent anti-inflammatory effects. It directly inhibits AGE formation at early, middle, and late stages in their development—more powerfully than standard chemical AGE-inhibitors. It also directly counters the sugar-induced mitochondrial damage caused by reduction in a survival protein called Bcl-2.
- **Benfotiamine** is a fat-soluble form of thiamine (vitamin B1). Its higher bioavailability allows it to strongly increase glycation-fighting thiamine levels in blood and tissues in normal people and in people with either type 1 or 2 diabetes. Benfotiamine powerfully reduces AGE production and damage to vascular endothelial cells under high-glucose conditions. It blocks three distinct pathways of sugar-induced tissue damage to protect against retinal damage in diabetes.
- **Pyridoxal phosphate** (PLP) is the biologically active form of vitamin B6. It is a powerful inhibitor of both protein and fat glycation. Glycation reductions by PLP are credited with reducing sugar-induced blood vessel and kidney damage from diabetes.

Each of these nutrients works through distinct pathways, acting as a “therapeutic cocktail” that provides maximum protection against glycation-induced toxicity and mitochondrial damage.

### MITOCHONDRIAL PROTECTION WITH A POTENT ADAPTOGEN

Long known to Ayurvedic practitioners for its healing power, shilajit is an organic substance harvested from biomass high in the Himalayas. It acts as a powerful adaptogen, providing broad systemic defense against stress and illness. Cutting-edge scientific analysis has isolated humic substances as the principal active ingredients that enhance mitochondrial energy flow.

---

**ADVANCED MITOCHONDRIAL THREATS: GLYCATION AND LIPOXIDATION**

- **Carnosine** is a nutrient comprised of two amino acids. It’s a natural antioxidant and anti-glycation molecule proven to reduce reactive oxygen and nitrogen species resulting from chronic glucose exposure, while also binding to potentially dangerous metal ions (chelation). These features make it attractive as an anti-aging, anti-Alzheimer’s agent.

- **Luteolin** is a flavonoid with potent anti-inflammatory effects. It directly inhibits AGE formation at early, middle, and late stages in their development—more powerfully than standard chemical AGE-inhibitors. It also directly counters the sugar-induced mitochondrial damage caused by reduction in a survival protein called Bcl-2.

- **Benfotiamine** is a fat-soluble form of thiamine (vitamin B1). Its higher bioavailability allows it to strongly increase glycation-fighting thiamine levels in blood and tissues in normal people and in people with either type 1 or 2 diabetes. Benfotiamine powerfully reduces AGE production and damage to vascular endothelial cells under high-glucose conditions. It blocks three distinct pathways of sugar-induced tissue damage to protect against retinal damage in diabetes.

- **Pyridoxal phosphate** (PLP) is the biologically active form of vitamin B6. It is a powerful inhibitor of both protein and fat glycation. Glycation reductions by PLP are credited with reducing sugar-induced blood vessel and kidney damage from diabetes.

Each of these nutrients works through distinct pathways, acting as a “therapeutic cocktail” that provides maximum protection against glycation-induced toxicity and mitochondrial damage.
In 2009, a series of landmark studies detailed for the first time how shilajit works on energy metabolism.

Mice subjected to strenuous exercise underwent expected ATP declines in muscle, blood, and brain tissue. When supplemented with shilajit, ATP loss was sharply reduced. Other biochemical markers of energy status also dramatically improved in the supplemented animals—including levels of CoQ10, which fell twice as fast in control mice as in supplemented animals. When given in combination, CoQ10 and shilajit displayed a powerful synergistic effect. Energy parameters such as CoQ10 levels increased significantly more than with either supplement alone.

Further analysis brought some of its key mechanisms of action to light. Shilajit contains two primary components, fulvic acid and DBPs (dibenzo-a-pyrones). Fulvic acid independently stimulates mitochondrial energy metabolism, protects mitochondrial membranes from oxidative damage, and helps channel electron-rich DBPs into the mitochondria to support the electron transfer chain. Fulvic acid works as an electron “shuttle,” augmenting CoQ10 to speed electron flow within mitochondria.

The DBPs in shilajit serve as electron “reservoirs,” replenishing electrons lost by CoQ10 when it donates them to free radicals (thereby neutralizing them). When laboratory mice are supplemented with oral CoQ10 alone, CoQ10 levels rise in heart, liver, and kidney tissue, as might be expected. When DBPs from shilajit are added to the supplement, CoQ10 levels rise still further—as much as 29% in the liver.

A recent study suggests that DBPs from shilajit preserve CoQ10 in its superior ubiquinol form.

Preliminary findings suggest that shilajit protects human tissue from lost energy in the form of ATP, while maximizing benefits from CoQ10, with dramatic improvement in exercise performance. In an as-yet unpublished study, people who took shilajit 200 mg once daily for 15 days registered 14% higher post-exercise ATP levels in the blood—equivalent to levels in people who hadn’t exercised at all. The average number of steps they took on a standardized dynamic exercise test rose significantly, and their mean fitness scores increased by 15%—without any intervening exercise training.

In pre-clinical studies, shilajit has been shown to possess a number of additional benefits, allowing it to work in synergy with CoQ10 to protect and support mitochondrial health:

• Preliminary unpublished studies showed that shilajit (250 mg twice daily for 90 days) lowered fasting blood sugar and a measure of systemic inflammation called the ESR (erythrocyte sedimentation rate), while increasing hemoglobin levels and platelet counts.

• Shilajit protected laboratory rats from developing chemically-induced diabetes through its free-radical scavenging properties.

• Shilajit augmented learning acquisition and memory retrieval in laboratory rats while reducing manifestations of anxiety during maze experiments.

• Shilajit reduced levels of the enzyme acetylcholinesterase that destroys the vital neurotransmitter acetylcholine. This effect may help to prevent or treat Alzheimer’s disease by maintaining levels of the neurotransmitter.

• Shilajit increased levels of the neurotransmitter dopamine in rat brains, making it an attractive candidate for treatment of Parkinson’s disease and other movement disorders.

• In pre-clinical studies, shilajit produced significant increases in the endogenous antioxidants superoxide dismutase (SOD), catalase, and glutathione peroxidase in brain tissue. Increased levels of these enzymes protect vulnerable brain cells against the oxidative damage that leads to brain aging and cognitive decline.