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## COVER STORY

**The Antiaging Effects of Acetyl-L-Carnitine**

New Research Yields Unexpected Benefits

Acetyl-L-carnitine is the biologically active form of the amino acid L-carnitine and has been shown to protect cells throughout the body against age-related degeneration. Most clinical research has focused on the brain, where improved mood, memory and cognition has been observed in response to acetyl-L-carnitine administration. By facilitating the youthful transport of fatty acids into the cell's mitochondria, acetyl-L-carnitine better enables dietary fats to be converted to energy and muscle. Carnitine is approved as a drug in the United States to protect against muscle wasting diseases, including heart muscle weakness and low energy levels. Despite FDA-approval, few conventional doctors prescribe carnitine to support those with cardiomyopathy, congestive heart failure, chronic fatigue, etc. The failure of doctors to prescribe this natural amino acid correlates directly with the lack of drug company advertising for the product. There is little economic motivation for drug companies to promote the benefits of carnitine to doctors when their patients can choose from hundreds of lower cost carnitine supplements available over the counter. In addition to its "FDA-approved" indications, acetyl-L-carnitine has been shown to maintain immune competence<sup>1</sup> and reduce the formation of a cell-clogging pigment called lipofuscin<sup>2</sup>. The most important anti-aging effect of acetyl-L-carnitine, however, is to work with coenzyme Q10 and alpha lipoic acid to maintain the function of the mitochondria<sup>3</sup>. When the mitochondria function dwindles, degenerative disease becomes an inevitable consequence. Foundation members use acetyl-L-carnitine as a multi-purpose anti-aging supplement. Newly published research shows this amino acid may be even more effective than previously shown.

In the early 1980s, acetyl-L-carnitine (ALC) was approved as a "drug" in Europe to treat heart and neurological disease. Americans had to wait until 1994 to legally buy acetyl-L-carnitine. Since this amino acid is sold as a "dietary supplement," it costs a lot less in the United States than it does overseas.

## Reversing heart aging

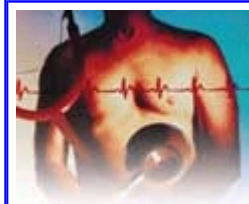
The effects of aging were dramatically demonstrated when scientists measured cell energy activity and respiration rates in the heart mitochondria of rats. Both cellular energy and respiration was depressed around 40% in the older rats. When acetyl-L-carnitine was administered, their heart rates became almost completely restored to the metabolic function level of young control rats<sup>4</sup>. This study showed that the heart mitochondrial content of cardiolipin, a key agent necessary for mitochondrial substrate transport, was markedly reduced in aged rats. Treatment of aged rats with acetyl-L-carnitine reversed the age-associated decline in cardiolipin content. This newly identified mechanism helps explain why acetyl-L-carnitine is so beneficial in treating congestive heart failure in humans.

## Brain protection

Aging causes alterations in brain cell metabolism. Acetyl-L-carnitine has been shown to counteract several mechanisms of brain cell damage. A new study shows that acetyl-L-carnitine protects against temporary cerebral ischemia (no blood flow) by maintaining the cell's energy cycle<sup>5</sup>. Other recent studies show that acetyl-L-carnitine protects brain cells against glutamate-induced and ammonia-induced toxicity<sup>6</sup>. As people grow older, circulation to the brain diminishes, which sets off a cascade of pathological events that results in neurological impairment. Acetyl-L-carnitine appears to protect against some of the known negative effects that aging induces in the brain.

## Emergency use of acetyl-L-carnitine

In animal stroke models, an 11-point neurologic deficit scoring system evaluated the treatment progression of acetyl-L-carnitine against a control vehicle. Acetyl-L-carnitine was shown to protect brain cells against ischemic injury and to improve neurological outcome with the treated animals being significantly improved over the controls. This study suggests that acetyl-L-carnitine might someday be used in hospital emergency rooms and stroke recovery centers to improve the prognosis of patients (with thrombotic or



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embolic stroke) who are often given little hope of full recovery.<sup>8</sup>

## Regenerating nerves

Acetyl-L-carnitine may facilitate nerve regeneration after nerve injury<sup>9</sup>. Scientists surgically severed nerves and observed the typical motor-neuron degeneration that occurred at the site of the injury. Acetyl-L-carnitine was shown to have significant neuro-protective effect against the degeneration of traumatized motor-neurons. These observations prompted the scientists to postulate a better hypotheses concerning motor-neuron regeneration and even the possibility of inducing neuronal proliferation. These findings have practical applications in those who have suffered from loss of nerve function.

Another study showed that acetyl-L-carnitine prevented ethanol-induced brain cell alterations indicative of human fetal alcohol syndrome.<sup>10</sup> The scientists who conducted this rat study stated that acetyl-L-carnitine might have an indirect anti-depressant benefit by protecting brain cells against the known neuro-toxicity effects of alcohol.

It is well known that many anti-viral HIV-drugs contribute to peripheral neuropathy. Doctors in London noted that treatment with acetyl-L-carnitine may assist in the treatment of drug-induced peripheral neuropathy.<sup>11</sup>

In two related studies of diabetic nerve degeneration and neuropathy, acetyl-L-carnitine was shown to accelerate nerve regeneration after experimental injury.<sup>12</sup> In the first study, doctors at the Hines VA Hospital in Illinois showed that diabetic rats treated with acetyl-L-carnitine maintained near normal nerve conduction velocity without any adverse effects on glucose, insulin or free fatty acid levels. These observations led the scientists to summarize that acetyl-L-carnitine can accelerate nerve regeneration after experimental injury. In another study, doctors at the Nagoya University School of Medicine in Japan showed that carnitine deficiency was closely related to the pathogenesis of diabetic neuropathy. The doctors concluded acetyl-L-carnitine has great potential for the treatment of this type of neuropathy.<sup>13</sup>

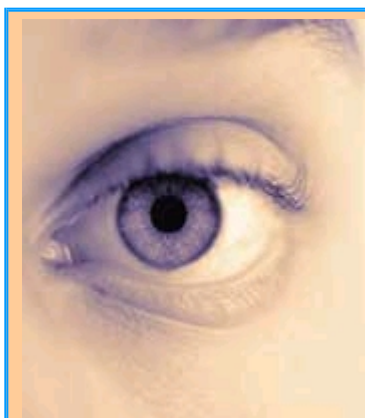
Traditionally, some diabetics have suffered with peripheral neuropathy at various times throughout the course of their illness. Scientists now know that several mechanisms may produce this neuropathy in diabetics. In 1997, French doctors published a study stating that some of the most promising treatments for diabetic neuropathy may be gamma linolenic acid (GLA), antioxidants, aminoguanidine and, once again, acetyl-L-carnitine.<sup>14</sup> It seems a particular enzyme in diabetics, which limits the availability of gamma linoleic acid, also decreases the endothelial synthesis of nitric oxide and of L-carnitine. The authors felt, though experimental, these treatments were a promising solution for diabetics.

Reports on acetyl-L-carnitine for the treatment of Alzheimer's disease have been contradictory. Some studies show encouraging degrees of efficacy, while other studies show no benefit. A placebo-controlled study at Stanford University School of Medicine in California showed that Alzheimer's disease patients under age 62 benefitted more from acetyl-L-carnitine than older patients.<sup>15</sup> The doctors concluded that acetyl-L-carnitine slows the progression of Alzheimer's disease in younger subjects. Though this is an important study, Alzheimer's patients over 61 may want to still consider ALC for its other known neurological benefits, which were not evaluated in this study.

Acetyl-L-carnitine enhances energy production in every cell of the body. Two recent studies illustrate the unique ability of acetyl-L-carnitine to increase cellular respiration in aging models. A study from Berkeley examined liver parenchymal cells in old mice after feeding them a 1.5% solution of acetyl-L-carnitine for one month. The results show that acetyl-L-carnitine supplementation significantly reverses the age-associated decline of mitochondrial membrane function.<sup>16</sup> A similar second study, also from Berkeley, again concluded the ability of acetyl-L-carnitine to reverse age-related mitochondrial decay.<sup>17</sup>



Acetyl-L-carnitine was shown to have a significant neuro-protective effect against the degeneration of traumatized motor-neurons



## Cataract prevention

Glycosylation and glycation are terms used to describe the binding of sugars to proteins that form non-functioning structures (crosslinks) in the body. Glycation-induced protein cross linking is most notable in the lense of the eye (cataract), the brain (senility) and the collagen of the skin. Protein glycation has been implicated in the development of cataracts. Scientists recently evaluated the effects of L-carnitine and acetyl-L-carnitine on the glycation of lens proteins. The results show that acetyl-L-carnitine suppresses glycation by 42%, but that l-carnitine has no effect.<sup>7</sup> Additional evaluation shows that acetyl-L-carnitine produces a 70%

reduction in one measurement of Advanced Glycation End products (AGEs). It is the

formation of AGEs that makes cataract irreversible. This in-vitro study shows, for the first time, that acetyl-L-carnitine (but not L-carnitine) may prevent cataract by preventing glycation-mediated protein damage in the eye lense.

### Suggested dosage

The optimal dose range of acetyl-L-carnitine for healthy people is 1000 mg to 2000 mg day. Those with neurological deficit should consider 3000 mg a day. Synergistic nutrients that could be taken with acetyl-L-carnitine include coenzyme Q10 (100-300 mg/day) and alpha lipoic acid (250-500 mg/day).

### Summary

A plethora of published studies on acetyl-L-carnitine has heightened our awareness of the multi-faceted benefits of this amino acid. Published research shows acetyl-L-carnitine is critical to youthful cellular function in the brain, heart, liver, peripheral nerve and immune system.<sup>18</sup>

Supplementation with acetyl-L-carnitine becomes an even greater consideration when we realize the potential antiaging effects this amino acid may produce when taken in combination with coQ10 and alpha lipoic acid.

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