

## NADH Energizes Mental and Physical Performance

By Edmund R. Burke, Ph.D.

Every living cell, from bacteria up to human, contains coenzyme nicotinamide adenine dinucleotide (NADH), a coenzyme critical to cellular energy production.<sup>1</sup> Cells that use the most energy, such as brain and muscle cells, also hold the highest amounts of NADH. Human heart cells, for instance, contain a whopping 90 mcg of NADH per gram of tissue.

Like Co-Q10, NADH is involved in the synthesis of adenosine triphosphate (ATP), the body's primary intracellular energy source.<sup>2</sup> When NADH is oxidized in cellular energy-producing organelles called mitochondria, and it forms water and energy. This energy is preserved as ATP. Every energy-consuming reaction requires ATP, so the more NADH a cell has available, the more energy it can produce. To keep up with the cellular demand for energy, the body continuously synthesizes NADH (a process that involves niacin, a B-complex vitamin).<sup>3</sup>

Although NADH occurs naturally in all plant and animal cells, its most plentiful sources are red meat, poultry and yeast. Vegetables are not as rich in NADH as animal tissues, because food processing, cooking and stomach acids can destroy the NADH present in most foods, sprinkling yeast and meals is a good way to increase NADH consumption.

### Mental and Physical Function

Scientific research increasingly suggests that supplemental NADH can improve mental and physical health. For instance, studies show that NADH dramatically boosts production of the neurotransmitter dopamine, a chemical messenger vital for short-term memory, involuntary movements, muscle tone and spontaneous physical reactions. It also mediates the release of growth hormone and dictates muscular movement. Without enough dopamine, muscles stiffen. The reaction is exemplified by the effects of Parkinson's disease—a disorder caused, in part, by destruction of the brain cells that synthesize dopamine.

#### Parkinson's disease:

Preliminary data suggest NADH may help ameliorate symptoms of Parkinson's disease— In an open trial, George Birkmayer, M.D., director of the Birkmayer Institute for Parkinson Therapy in Vienna, Austria, gave NADH to 885 people with Parkinson's disease. Nearly half of the patients received NADH (12.5 mg) by intravenous infusion, while the remaining patients took NADH orally in capsules; nearly 80 percent of the patients had a beneficial clinical effect: 19.3 percent showed a very good (30 to 50 percent) improvement, 58.8 percent a moderate (10 to 30 percent) improvement. Out of all the patients, 21.8 percent did not respond to NADH. The benefits of oral NADH were comparable to the injections. Younger patients and those with a shorter disease duration stood a better chance of improvement than older patients and those with a longer disease duration.<sup>4</sup>

#### Depression:

NADH enhances the synthesis of another neurotransmitter, Norepinephrine (noradrenalin) that contributes to alertness, concentration and mental activity. Dopamine and Norepinephrine are "feel-good" brain chemicals; decreased brain levels of either can lead to depressed mood. Drugs that raise the brain levels of dopamine and Norepinephrine can elevate mood to the point of euphoria, as illustrated by the effect of cocaine, a drug that blocks the breakdown of both neurotransmitters.

synthesis of both dopamine and Norepinephrine, NADH appears to Birkmayer looked at the effect of NADH on 205 patients suffering from depression. NADH was given orally (5 mg), intramuscularly (12.5 mg) or intravenously (12.5 mg) for five to 310 days. Ninety-three percent of the patients exhibited a beneficial clinical effect. The overall improvement was 11.5 points on a test that measured depression severity, yet the improvement was not statistically significant.<sup>5</sup>

### **Alzheimer's disease:**

Several preliminary studies show NADH may help treat Alzheimer's disease. In yet another study by Birkmayer and colleagues, 17 patients suffering from dementia of the Alzheimer type received NADH for eight to 12 weeks. As measured by the Mini-Mental State Examination and the global deterioration scale, the patients' cognitive dysfunction improved. No side effects or adverse effects were reported<sup>6</sup> this pilot study was an "open-label trial," meaning subjects and researchers knew they were using NADH, so no definitive conclusions can be drawn from it. Demonstrating the clinical efficacy of NADH for Alzheimer's disease will require a double-blind, placebo-controlled study.

### **Aging:**

One theory about the aging process postulates that cells begin to age when deoxyribonucleic acid (DNA) repair becomes inefficient. DNA repair requires NADH. Furthermore, much of the constant attack on cellular DNA comes from free radicals, renegade by-products of normal oxygen metabolism. NADH, a potent-free-radical scavenger, targets these dangerous by products and helps ensure cellular integrity.<sup>7</sup>

### **NADH and Athletic Performance**

Researchers are just beginning to look at NADH's possible applications for athletic performance. Theoretically, physiologic functions boosted by NADH could have beneficial effects for athletes. Research conducted by Birkmayer and colleagues on competitive athletes does indicate that NADH enhances work capacity. Researchers measured reaction times, physical performance and performance quality in 17 competitive cyclists and long-distance runners. Physical performance was measured on a bicycle ergometer. Performance quality was determined by measurements of continuous attention.

Athletes underwent these tests both before and after taking 5 mg of NADH before breakfast each morning for four weeks. During the test period, subjects kept constant the frequency and intensity of their training and exercise program as well as lifestyle factors. After four weeks of NADH supplementation, most athletes experienced significantly less scattering of reaction times-it dropped by 10 percent in five athletes, 10 to 20 percent in eight athletes, and more than 20 percent in three athletes. Reaction time overall improved considerably in 16 out of the 17 subjects.

Compared to baseline measurements, parameters for physical performance also improved. For two athletes, the maximum work performance (work at max per kg/body weight) increased by more than 10 percent, with another seven showing increases of up to 10 percent. Similar improvements were made in maximum oxygen uptake ( $VO_{2max}/kg$ ).<sup>8</sup>

Researchers hypothesized that improved reaction times may have resulted from prior NADH deficiency in some athletes or an increase in dopamine production that led to increased alertness and vigilance. The latter explanation is further supported by studies wherein NADH supplementation increased dopamine production in rats.<sup>9</sup> The researchers went on to say that stimulation of cellular ATP production by NADH may have enhanced, athletic performance. Theoretically, the more NADH a cell has available, the more energy it can produce. Conversely, an NADH deficiency results in reduced strength, power and

in the changes observed after taking NADH for four weeks, it was a placebo-controlled study with a larger number of athletes."

### Safety and Continued Research

NADH is now available as a dietary supplement for people whose lifestyle demands increased energy, vitality and mental activity. Even in high concentrations, NADH has demonstrated no toxicity or adverse effects.<sup>10</sup> Current studies and clinical trials both in the United States and abroad are exploring NADH's full potential for improved health and athletic performance,

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### REFERENCES

1. Lehninger, A. L. Vitamins and Coenzymes, Biochemistry, 2nd Ed.: 337-42. The John Hopkins University School of Medicine, New York: Worth Publishers Inc., 1975.
- 2- Devlin, T.M. Biochemistry with Clinical Correlations, 3rd Ed.: 559-63. Hahnemann University School of
3. Alberts, B., et al. Energy Conversion: Mitochondria and Chloroplasts, Molecular Biology of the Cell, 3rd Ed.; 653-720, New York: Garland Publishing Inc., 1994.
4. Birkmayer, I.G.D., et al. "Nicotinamide adenine dinucleotide (NADH)--a new therapeutic approach to Parkinson's disease: Comparison of oral and parenteral application," Acta Neurological Scandinavia 87 (Suppl 146). 32-35, 1993.
5. Birkmayer, I.G.D., & Birkmayer, W. "The coenzyme nicotinamide adenine dinucleotide (NADH) as biological antidepressive agent experience with 205 patients." New Trends in Clinical Neuropharmacology (in press).
6. Birkmayer, J.G.D. "Coenzyme nicotinamide adenine dinucleotide: New therapeutic approach for improving dementia of the Alzheimer type," Annals of Clinical and Laboratory Science, 26(1): 1-9, 1996.
7. Birkmayer, J.G.D. Energy for Life: NAD14, The Energizing Coenzyme: 6-11. New York: Menuco Corp., 1996.
8. Birkmayer, I.G.D., & Vank, P. "Reduced coenzyme 1 (NADH) improves psychometric and physical performance in athletes." White Paper Report, New York; Menuco Corp., 1996.
9. Gardler, A.M. "Effects of acute and chronic NADH administration on peripheral and central Norepinephrine and dopamine synthesis in the rat." Birkmayer Institut fur Parkinsontherapie, Internal Lab Report (No. 94070401).
10. Birkmayer, I.G.D., & Vank, P. op. cit.,