Energy is our most precious resource. With age, both our physical and cellular energy levels decline. Not only do we feel tired, but our cells become fatigued and fail to optimally function. Additionally, our heart muscle weakens and does not contract as fully, often leading to congestive heart failure. D-ribose can help replenish the metabolic energy needed by all our cells, including those in major organs such as our heart and brain. The result? Increased vitality, along with improved cardiac and neurological function.

Ribose serves a number of other key processes in the body. Long chains of d-ribose are strung together to form ribonucleic acid or RNA, the DNA-like structures essential to copying our genes and translating them into functioning proteins. D-ribose provides antioxidant protection for body tissues. Even the immune system needs d-ribose to power its response to infection.

In this article, you'll learn how d-ribose supplementation can assure that vital body processes aren't starved of essential energy molecules.

**BROAD CARDIOVASCULAR SUPPORT**

Cardiovascular disease has multiple and interlinked causes. That's why no single drug or therapy can ever fully prevent or repair, cardiovascular damage.

It's also the reason that, generally, heart patients are on multiple medications—to deal with the complexity of their disease.

Supplemental d-ribose is an excellent candidate as a cardioprotectant, because it serves **multiple targets**. It provides defense against heart disease along the entire continuum of events that can lead to cardiac catastrophe.

D-ribose powerfully protects heart tissue against ischemia-reperfusion injury. This is the serious damage that occurs in the minutes to hours following a heart attack or stroke, when oxygen-starved (ischemic) tissue is suddenly flooded with oxygen-rich blood as circulation is restored (reperfusion). The sudden availability of oxygen in already-damaged tissue sets off a deadly chain of events, culminating in release of free oxygen radicals and harmful inflammatory responses.

But if high levels of ribose are made available before and immediately after the reperfusion occurs, most of those dangerous changes can be prevented, largely through ribose's actions on inflammatory blood cells. This effect is so potent that some forward-looking anesthesiologists and surgeons have suggested using IV infusions of ribose during surgical procedures in which ischemia-reperfusion injury is common.
Ischemia, however, is not always an acute event with immediate consequences. Much more commonly, low-level ischemia occurs on a continuing basis in people with advancing coronary artery disease, gradually producing symptoms such as angina (chest pain) with exertion. As ischemia worsens, the pain can occur even while the patient is at rest.

Each episode of angina represents steady depletion of cellular energy levels, with loss of the energy molecule, ATP from heart muscle cells.\textsuperscript{13,14} This uses up the heart's normal supply of d-ribose. Under these circumstances, d-ribose becomes a conditionally essential nutrient.\textsuperscript{15}

Continued long enough, this cellular energy starvation is a major contributor to congestive heart failure (CHF), in which heart muscle can't "squeeze" hard enough to move blood efficiently.\textsuperscript{16} The result is that fluid accumulates in tissues throughout the body as a result of poor cardiac "squeeze" (technically called contractility). The end result is progressive exercise intolerance, increasing difficulty breathing, and fluid retention. In the extreme, congestive heart failure can result in the deadly accumulation of fluid in the lungs—known as pulmonary edema—that is the ultimate cause of death for many victims of heart disease.

Many people with congestive heart failure find themselves on multiple medications aimed at reducing fluid accumulation or chemically increasing the heart's contractility. While these drugs can have some success, none are curative, and most have substantial side effects that can limit their utility.

Fortunately, congestive heart failure can be partially reversed, more readily if it is detected and treated early.

**POTENT CARDIOPROTECTANT**

Increasingly, scientists are investigating the ischemia-energy relationship that links the severity of heart muscle damage to the supply of energy-mediating nutrients such as d-ribose.\textsuperscript{17-19}

A noted cardiologist and author Stephen T. Sinatra, MD, who has written extensively on the cardiac benefits of d-ribose, recently stated, "Many physicians are not trained to look at heart disease in terms of cellular biochemistry...."\textsuperscript{19} But the growing interest in this field over the past decade opens the door to safer and much more effective therapy with cardiac energy preparations based on d-ribose, providing metabolic support for ailing heart muscle.\textsuperscript{13}

The benefits of d-ribose began to interest researchers in the early 1990s. Those early studies were mainly focused on d-ribose as an aid in radiology techniques such as thallium scanning, which indicate areas of ischemia in the heart. Researchers found that by infusing d-ribose intravenously during the scan, they could see many more areas of heart muscle—because much more blood was permeating those tissues.\textsuperscript{6,20}

Too often, individuals with coronary disease have limited mobility or are unable to engage in moderate exercise due to such limitations as lack of energy. German researchers found that they could use d-ribose to increase exercise tolerance in people with severe coronary artery disease and chronic ischemia.\textsuperscript{10} They gave patients an oral dose of 60 grams daily in four divided doses for just 3 days to achieve gains in endurance.

More recently, a different German group showed that d-ribose could improve heart function, as seen on echocardiograms, while also improving quality of life in patients with congestive heart failure.\textsuperscript{21}

Through the recovery of ATP energy molecules and an increase in the heart muscle's energy levels, d-ribose improves heart muscle contractility—the "squeeze" needed to pump blood efficiently to the lungs and the body in general.\textsuperscript{22,23}

When d-ribose was given intravenously to patients who have suffered one or more heart attacks, scientists found that the d-ribose increased the number of heart segments with good contractility, a visible marker of improved function.\textsuperscript{24}

D-ribose's replenishment of heart muscle energy levels has additional benefits, as was shown in a recent study of patients with advanced congestive heart failure and extreme exercise intolerance.\textsuperscript{25} Researchers gave these patients d-ribose at 15 grams a day in three doses. The patients all had impressive improvement in their ability to breathe and ventilate their lungs, and a 44% improvement in their heart failure classification! These changes were significant, because they meant that this group of severely impaired patients could move about more freely and with increased comfort.

**NEUROPROTECTION**

D-ribose has unique protective effects specific to brain cells.
In a recent study, cardiologists revealed that d-ribose not only improves heart function and blood flow—but also has a profound impact on brain tissue during the period of low blood pressure that can follow a heart attack. D-ribose reduced expression of a protein that triggers cell death in brain cells deprived of blood flow. This can also be a life-saving defense in the case of a stroke.

The neuroprotective effect of d-ribose has major implications, because heart attacks and strokes contribute enormously to the age-related cognitive decline that is so prevalent today.

The neuroprotective benefits of ribose may spring partly from the antioxidant effects it provides throughout the body. But it is ribose’s remarkable ability to restore energy-depleted tissues back to near-normal that is generating enthusiasm among scientists.

Supplementation with d-ribose increases the available amounts of ATP in brain tissue, just as it does in heart muscle. This is important, because the brain uses an enormous proportion of our total energy resources.

What You Need to Know

D-ROSE: INCREASING CELLULAR ENERGY

- **Cellular energy management** is of increasing interest to physicians caring for patients with cardiovascular disease and many other age-related conditions. Reduction in cells’ ability to use available energy exposes tissues to increased risk of damage by oxidants and inflammatory reactions, and reduces organs’ efficiency.
- D-ribose is central to energy metabolism, forming the backbone of the vital ATP molecule that cells use to transfer energy. Cellular damage by oxidants, inflammation, and ischemia/reperfusion injury causes loss of ATP and increased vulnerability to disease.
- Supplementing with d-ribose restores cellular ATP to normal levels, providing powerful protective benefit in cardiovascular disease, even following a heart attack, congestive heart failure, or stroke.
- Supplemental d-ribose also holds promise for management of kidney disease, and even frustrating conditions such as fibromyalgia and restless leg syndrome.
- New discoveries about d-ribose make it one of today’s hottest topics in the context of how we understand the relationship of energy management and chronic illness.

REPORT

Restoring Cellular Energy Metabolism

By Kirk Stokel

FIBROMYALGIA

*Fibromyalgia (FM) and chronic fatigue syndrome* are conditions that often occur together and are believed to have a similar underlying cause.
There's accumulating evidence that defective production of ATP is the culprit. These findings make d-ribose a natural candidate as a therapy for those suffering from fibromyalgia and chronic fatigue syndrome. A published case study showed that a woman with fibromyalgia experienced a decrease in symptoms following supplementation with d-ribose. The patient had been unresponsive to prior medications, and her physicians based their decision on the known energy-enhancing capabilities of d-ribose.

A larger study soon followed enlisting 41 patients with fibromyalgia or chronic fatigue syndrome. Subjects took 5 grams of d-ribose three times daily until they reached a total of 280 grams. There was significant improvement in all five categories on a standard score: energy, sleep, mental clarity, pain intensity, and well-being. On average, patients reported a 45% increase in energy levels.

While fibromyalgia and chronic fatigue syndrome remain complicated and perplexing to scientists, these findings offer real hope for a solution.

RESTLESS LEG SYNDROME

Restless leg syndrome (RLS) is a common disorder that affects as many as 15% of the US population, and it is severe enough to warrant medical treatment in more than a third of those people. The condition involves an uncontrollable urge to move the legs, accompanied by uncomfortable sensations, and it is usually worse at night. Only a few medications offer even partial relief of restless leg syndrome, and many make the condition worse—leaving sufferers without much recourse.

Disordered energy metabolism has been suggested as one possible cause of restless leg syndrome. Low levels of adenosine, the d-ribose-containing central molecule in ATP, have been reported in those suffering from restless leg syndrome.

Based on that observation, one study has been carried out in which daytime symptoms were eliminated, and nighttime symptoms significantly reduced, on daily doses of 15 grams of d-ribose, taken as one 5-gram dose with breakfast, lunch, and dinner.

It's clearly too early to claim that d-ribose cures the condition, but these encouraging findings—coupled with complete absence of side effects—warrant further investigation.

UNGROUNDED FEAR: CAN D-RIBOSE CAUSE GLYcation REACTIONS?

It is now generally accepted that d-ribose supplementation provides many health benefits, particularly in the area of cellular energy management. Several recent publications, however, have raised the question of whether d-ribose—because it is a sugar—could possibly contribute to development of harmful advanced glycation endproducts.

The truth seems to be straightforward: Like any sugar, ribose can indeed cause protein glycation, with resulting damage to tissues. And when ribose is administered experimentally at the same high dose as glucose, ribose quickly causes the protein cross-linking that is the outcome of glycation.

But those studies used artificially high doses and concentrations of ribose, levels never found in humans—even after high-dose supplementation.

For example, in a human study of d-ribose supplementation at doses of 20 and 53 grams over a 4-hour period, peak serum ribose levels rose to only 4.8 mg/dL and 81.7 mg/dL, respectively.

But doses used in the glycation experiments were significantly higher, up to 30 times higher than achievable in human blood.

And in an experiment showing that d-ribose induced glycation and impaired spatial cognition in mice, the ribose...
concentrations used were equivalent to blood levels of **150 to 750 mg/dL**, clearly vastly higher than have been used in human studies.\(^{43,44}\)

Researchers seeking to show that ribose-induced glycation could enhance cartilage damage in an animal model of osteoarthritis showed conclusively that even **direct injection** of ribose into the joint was incapable of triggering sufficient glycation to cause injury.\(^{45,46}\)

The doses for d-ribose studies reported in this article—**15 to 60 grams per day** in divided doses—are incapable of causing serum ribose concentrations high enough to get anywhere near the risk of excessive glycation reported in the lab studies.\(^{44}\)

Also, most human studies recommended splitting the total amount into **three daily doses**; this approach provides even greater assurance that serum d-ribose remains well within safe levels.

KIDNEY PROTECTION

Like the brain and heart, the human kidney receives a a high proportion of the body's total blood flow—which makes it equally vulnerable to damage by ischemia-reperfusion mechanisms, the loss and restoration of blood flow.

These kidney injuries can occur as the result of trauma or during any major surgery, sometimes worsened by chronic conditions such as cardiovascular disease and diabetes.\(^{35-37}\)

Growing evidence suggests that an **immune activation** and inflammatory response following this kind of kidney injury creates the bulk of the damage, especially in those with diabetes.\(^{12,38}\) Adenosine, which is partly made from d-ribose, is an important regulator of kidney function, and is especially vital during times of injury.\(^{39}\) These observations—coupled with what we know about d-ribose as antioxidant and anti-inflammatory—have aroused considerable interest among kidney researchers.

Japanese scientists have led the way in investigating d-ribose as a kidney protector. They have found that in rats subjected to renal ischemia-reperfusion—similar to what can occur during major surgery—d-ribose significantly reduced the release of inflammatory cytokines.\(^{12}\) Kidney function and appearance following the injury was improved substantially.

They also showed that d-ribose reduces activation of **neutrophils**, the ubiquitous white blood cells that are the first to arrive at the scene of an injury but that also release toxic chemicals and oxygen radicals that can cause additional harm.\(^{11}\)

Clearly researchers are only beginning to realize the substantial potential of d-ribose for kidney health.

SUMMARY

D-ribose is an essential component in our bodies' **cellular energy management** systems. Additionally, it provides antioxidant, anti-inflammatory, and gene regulatory capabilities. Together these characteristics make it of compelling interest to forward-thinking clinicians and patients.

Supplemental d-ribose demonstrates cardioprotection—even late in the disease process when heart attacks have already occurred, and when heart failure is developing. D-ribose helps ailing heart muscle maximize its effort, and improves blood flow to oxygen-starved cardiac tissue.

D-ribose supplements are only just being explored for similar benefits in brain and kidney tissues, but recent studies offer great hope in those areas. Even perplexing conditions such as fibromyalgia and restless leg syndrome seem to be yielding to the energy-related benefits of d-ribose. •

If you have any questions on the scientific content of this article, please call a Life Extension® Health Advisor at 1-866-864-3027.
Restoring Cellular Energy Metabolism

By Kirk Stokel

REFERENCES


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