

VITAMIN C

By Dr. Mercola

Vitamin C is one of the most well-established traditional antioxidants we know of, and its potent health benefits have been clearly demonstrated over time, especially for the prevention and treatment of infectious diseases.

A perfect example of the healing power of this antioxidant vitamin is the dramatic case of Allan Smith, who contracted a serious case of [swine flu](#), and was brought back from the brink of death using a combination of IV and oral vitamin C.

While most animals have the ability to produce vitamin C internally, three species cannot. Guinea pigs, primates, and humans must obtain their vitamin C from their diet.

Vitamin C has numerous functions in the human body,¹ including acting as an essential cofactor in enzymatic reactions.

In this way, it plays a role in your body's production of collagen, carnitine (which helps your body turn fat into energy), and catecholamines (hormones made by your adrenal glands).

Vitamin C is also used by your body for wound healing, repairing, and maintaining the health of your bones and teeth, and plays a role in helping your body absorb iron.

A powerful [antioxidant](#), vitamin C also helps prevent damage caused by free radicals. Over time, free radical damage may accelerate aging and contribute to the development of heart disease and other health conditions.

It's through this antioxidant effect that it's thought vitamin C may play a role in protecting heart health.

Linus Pauling — 'The Vitamin C Man'

One of the most famous forerunners of high dose vitamin C treatment for colds and other disease was Linus Carl Pauling (1901-1994), a physical chemist and peace activist who won two Nobel Prize awards; one in chemistry in 1954, followed by a Nobel Peace Prize in 1962.

The New Scientist magazine ranked him as one of the 20 greatest scientists to ever live. He almost won a third Nobel, but Watson and Crick narrowly beat him to the discovery of the structure of DNA.

Despite being a well-respected scientist, his views on vitamin C were all firmly rebuffed by the medical community.

He detailed his discoveries in a series of books, starting with *Vitamin C and the Common Cold* in 1970, followed by *Vitamin C, the Common Cold and the Flu* (1976), *Vitamin C and Cancer* (1979), and *How to Feel Better and Live Longer* (1986).

Many felt Pauling was too far out of his field of expertise with his research into nutrition, and he was largely ignored by mainstream medicine and nutritional science.²

Was Pauling Right About Vitamin C After All?

While the recommended daily allowance (RDA) for vitamin C had been established at 40 to 60 mg per day — an amount more than sufficient to prevent scurvy — Pauling advocated amounts of 1,000 mg or even higher.

Pauling himself is said to have taken 12,000 mg per day. He noted that veterinarians recommended far higher doses of vitamin C for primates than what was recommended for people.

So he initially extrapolated the dosages from monkeys, and determined that humans likely need a minimum of six grams per day — 200 times more than the RDA.

The video above features the late Pauling and his controversial claims about the curative powers of vitamin C, which included cancer and heart disease — the latter of which he claimed was a form of pre-scurvy.

Pauling died of prostate cancer in 1994 at the age of 93. However, interest in vitamin C certainly did not die with him.

On the contrary, there's been an explosion of research into the properties of vitamin C, and newer evidence suggests there might be something to Pauling's heretical claims after all. In fact, a lot of the scientific literature published on vitamin C in the two decades since Pauling's death support his claims.^{3,4}

UCLA Researchers Confirm Vitamin C Protects Against Heart Disease

For example, the video features Dr. Balz Frei, a researcher at Harvard University's Department of Nutrition.

According to Dr. Frei, interest in vitamin C was renewed when it became known that many degenerative diseases involve oxidation, *"and it is clear that vitamin C can very effectively prevent many of these oxidation processes, because it is a very strong antioxidant,"* he says.

A large, decade-long research study led Dr. James Engstrom at the UCLA also found that men who took 800 mg of vitamin C per day — which is more than 10 times the RDA — had less heart disease and lived up to six years longer than those following the conventional guideline of 60 mg/day.

Another study⁵ that included nearly 11,200 elderly people, published in 1996, found that seniors who took high-potency vitamin C and E had an overall reduced mortality rate of 42 percent.

Low potency "one-a-day" multiple vitamins had no beneficial effect on mortality. About 40 studies have also shown that people who eat vitamin C-rich diets have a lower incidence of cancer.

Vitamin C Shown to Be Selectively Cytotoxic to Cancer Cells

Five years ago, I interviewed Dr. Ronald Hunninghake about his experience with high-dose vitamin C treatments. He's an internationally recognized expert on vitamin C who at the time had personally supervised more than 60,000 intravenous (IV) vitamin C administrations.

He got his start in this field some 27 years ago when he teamed up with Dr. Hugh Riordan, who conducted research on intravenous (I.V.) vitamin C for cancer patients.⁶ Dr. Riordan discovered that most cancer patients are deficient in vitamin C, especially those in advanced stages of cancer.

Dr. Riordan carried out a 15-year long research project called RECNAC (cancer spelled backwards). His groundbreaking research in cell cultures showed that vitamin C was *selectively cytotoxic* against cancer cells. The mechanism for this is summarized in an article by Dr. Hunninghake on Orthomolecular.org:⁷

"Cancer cells were actively taking up vitamin C in a way that depleted tissue reserves of C. PET scans are commonly ordered by oncologists to evaluate their cancer patients for metastases (cancer spread to other organs).

What is actually injected into the patient at the start of the scan is radioactive glucose. Cancer cells... depend upon glucose as their primary source of metabolic fuel... [and] employ transport mechanisms called glucose transporters to actively pull in glucose.

In the vast majority of animals, vitamin C is synthesized from glucose in only four metabolic steps. Hence, the molecular shape of vitamin C is remarkably similar to glucose. Cancer cells will actively transport vitamin C into themselves, possibly because they mistake it for glucose. Another plausible explanation is that they are using the vitamin C as an antioxidant. Regardless, the vitamin C accumulates in cancer cells.

If large amounts of vitamin C are presented to cancer cells, large amounts will be absorbed. In these unusually large concentrations, the antioxidant vitamin C will start behaving as a pro-oxidant as it interacts with intracellular copper and iron. This chemical interaction produces small amounts of hydrogen peroxide.

Because cancer cells are relatively low in an intracellular anti-oxidant enzyme called catalase, the high dose vitamin C induction of peroxide will continue to build up until it eventually lyses the cancer cell from the inside out! This effectively makes high dose IVC a non-toxic chemotherapeutic agent that can be given in conjunction with conventional cancer treatments.

Based on the work of several vitamin C pioneers before him, Dr. Riordan was able to prove that vitamin C was selectively toxic to cancer cells if given intravenously. This research was recently reproduced and published by Dr. Mark Levine at the National Institutes of Health."

Vitamin C As an Adjunct to Cancer Therapy

Most recently, researchers at the Lewis Cantley of Weill Cornell Medicine in New York published a paper⁸ showing that high doses of vitamin C help kill and eliminate colorectal cancer cells with certain genetic mutations. According to the International Business Times:⁹

"Since over half of the colorectal cancer cases in humans are linked to mutations in the KRAS and BRAF genes, the researchers believe that their study findings call for more research into the therapeutic use of vitamin C for colorectal cancer cases."

According to the National Cancer Institute,¹⁰ other studies have shown high-dose vitamin C can help slow the growth of prostate, pancreatic, liver, and colon cancer cells. The institute also recognizes human studies showing IV vitamin C can help improve symptoms associated with cancer and cancer treatment, such as fatigue, nausea, vomiting, pain, and loss of appetite.

Despite all of these benefits, the US Food and Drug Administration (FDA) has not approved IV high-dose vitamin C for the treatment of cancer or any other disease.

A More Potent and Foundational Treatment for Cancer

The treatment of cancer, neurodegenerative diseases like [Alzheimer's](#), ALS, and Parkinson, and anti-aging have become one of my new passions. Why? Because they all share the same primary metabolic defect — dysfunctional mitochondria. Dr. Otto Warburg was an M.D., Ph.D. and most experts consider him to be the most brilliant biochemist of the 20th century.

He received his Nobel Prize in 1931 for discovering that virtually every cancer cell does not use oxygen to create energy, but it ferments glucose to provide all its energy.

Interestingly, this use of glucose may contribute to a relative vitamin C deficiency since it is produced from glucose, and may explain some of its benefits in the treatment of cancer. However I am firmly convinced that vitamin C does not treat the primary defect responsible for most cancers, which is mitochondrial dysfunction.

The best way to address this mitochondrial damage that I am aware of is a [ketogenic diet](#). This is achieved typically by a reduced calorie and carbohydrate diet that limits all sugars, grains, and most fruits. I am currently in the process of connecting with the leading experts in the world on this and will greatly expand on this exciting news in the near future.

Vitamin C Deficiency May Be an Independent Risk Factor for Stroke

While scurvy is the most well-known side effect of vitamin C deficiency, French researchers have also reported that those with vitamin C deficiency are at an increased risk for a lethal hemorrhagic stroke.¹¹ According to the authors, vitamin C deficiency "should be considered a risk factor for this severe type of stroke."

They also pointed out that previous studies have found vitamin C may help regulate [blood pressure](#), and that higher blood levels of vitamin C have been found to reduce stroke risk by more than 40 percent.

A 20-year long prospective cohort study¹² in Japan found that those with the highest serum levels of vitamin C had a 29 percent lower risk for stroke compared to those with the lowest serum levels. Moreover, people who ate vegetables six to seven days a week had a 54 percent reduced risk of stroke compared to those who only ate vegetables two days or less per week.

A common denominator here is the way vitamin C affects your blood vessels. Vitamin C helps dilate blood vessels, and is required for the biosynthesis of collagen, which helps keep your blood vessels strong and intact. Lack of vitamin C can therefore lead to a weakening of your blood vessels, resulting in scurvy symptoms like subcutaneous bleeding, or the lethal hemorrhaging associated with hemorrhagic stroke.

Vitamin C Performs Many Functions That Boost Health

Vitamin C has two major functions that help explain its potent health benefits. First, it acts as a powerful antioxidant. It also acts as a cofactor for enzymatic processes. In addition to that, vitamin C is a "reducing agent," which means it donates electrons to other molecules, thereby reducing oxidation. As explained by the Linus Pauling Institute:¹³

"Vitamin C is the primary water-soluble, non-enzymatic antioxidant in plasma and tissues. Even in small amounts vitamin C can protect indispensable molecules in the body, such as proteins, lipids (fats), carbohydrates, and nucleic acids (DNA and RNA), from damage by free radicals and reactive oxygen species (ROS) that are generated during normal metabolism, by active immune cells, and through exposure to toxins and pollutants..."

Vitamin C also helps regenerate vitamin E from its oxidized form, and is involved in the metabolism of cholesterol to bile acids, the latter of which may help reduce cholesterol and gallstones. Vitamin C also boosts your body's ability to absorb iron from the foods you eat, and plays a role in detoxification, as it helps neutralize and eliminate a range of toxins from your body.¹⁴

Signs and Symptoms of Vitamin C Deficiency

In the U.S., serious vitamin C deficiency is rare; however many people do have low levels. If you're elderly, for instance, you may have higher requirements for vitamin C, as aging may inhibit absorption. [Smokers](#) may also require more vitamin C due to the increased oxidative stress from cigarette smoke. Signs that you may need more vitamin C include:

Dry and splitting hair	Nosebleeds	Decreased wound-healing rate	Bleeding gums
Rough, dry or scaly skin	Gingivitis (inflammation of your gums)	Decreased ability to ward off infection	Easy bruising

What's the Best Way to Optimize Your Vitamin C?

The ideal way to optimize your vitamin C stores is by eating a wide variety of fresh whole organic locally grown foods, primarily vegetables and fruits. A number of people, primarily with the naturopathic perspective, believe that in order to be truly effective, ascorbic acid alone is not enough. They believe it's the synergistic action of the ascorbic acid *in combination* with its associated micronutrients, such as bioflavonoids and other components that produce the full range of benefits.

Eating a colorful diet (i.e. plenty of vegetables) helps ensure you're naturally getting the phytonutrient synergism needed. Particularly rich sources of vitamin C include those in the following list. One of the easiest ways to ensure you're getting enough vegetables in your diet is by juicing them. For more information, please see [my juicing page](#). You can also squeeze some fresh lemon or lime juice into some water for a vitamin C rich beverage.

Sweet peppers	Chili peppers	Brussels sprouts
Broccoli	Artichoke	Sweet potato
Tomato	Cauliflower	Kale
Papaya	Strawberries	Oranges
Kiwi	Grapefruit	Cantaloupe

What You Need to Know About Vitamin C Supplements

In some cases, it may still be wise to take supplemental vitamin C. The most effective form of oral vitamin C supplementation is liposomal vitamin C, which I was introduced to by Dr. Thomas Levy, who is one of the leaders in this area. Liposomal vitamin C bypasses many of the complications of traditional vitamin C or ascorbic acid (such as gastrointestinal distress), thereby allowing you to achieve far higher intracellular concentrations.

There are also other forms of vitamin C on the market, such as buffered forms of sodium ascorbate. One example would be Ester-C. These buffered forms are also effective and do not cause the gastrointestinal distress associated with conventional ascorbic acid.

When taking an oral vitamin C, be mindful of your dosing frequency. A researcher with a Ph.D. in medical biophysics, Steve Hickey, wrote the book "Ascorbate", which shows that if you take vitamin C frequently throughout the day, you can achieve much higher plasma levels. So even though your kidneys will tend to rapidly excrete the vitamin C, by taking it every hour or two, you can maintain a much higher plasma level than if you take one mega-dose all at once (unless you're taking an extended release form of vitamin C).

As noted by the Linus Pauling Institute,¹⁵ experiments have demonstrated that plasma vitamin C concentration is controlled by three primary mechanisms: intestinal absorption, tissue transport, and renal reabsorption. You can expect a significant rise in plasma vitamin C concentration at doses between 30 and 100 mg/day.

At 200 to 400 mg/day, healthy young adults reach a steady-state concentration of 60 to 80 micromoles/L, and ingesting doses of 200 mg at a time has been shown to maximize absorption efficiency.

According to Dr. Andrew Saul, editor of the Orthomolecular Medicine News Service, if everyone were to take 500 mg of vitamin C per day — the dose typically required to reach a healthy level of 80 $\mu\text{mol/L}$ — an estimated [216,000 lives could be spared](#) each year.