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## Protecting Against Viruses and Other Threats to Wellness: The Roles of Cysteine and Selenocysteine

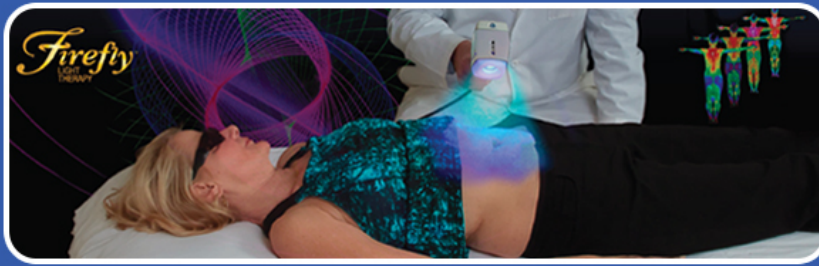
**Michael Passwater**

*Orthomolecular Medicine News Service*

Influenza cases are on the rise in the United States with over 1300 hospitalizations and 9 deaths during the first week of October 2022. Respiratory syncytial virus (RSV) is rising sharply, and another 898 people died with Covid-19 as a primary or contributing cause of death. The list of Covid-19 variants continues to grow: BA.5, BA.4.6, BF.7, BQ.1, BQ.1.1. In Uganda, the Sudan Ebola virus has afflicted at least 80 people and killed 44. The World Health Organization recently reminded us that in spite of the persistent threat of infectious diseases, heart disease and cancer remain the leading killers of humans worldwide.

### **Nutritional Treatments**

With so many threats from so many different directions, what can a person do? The advice of W. Todd Penberthy, PhD comes to mind, "Adequate amounts of essential nutrients and sufficient high-quality sleep can enable the body to recover from virus-induced deficiencies of essential molecules and prevent death due to sepsis.... it is best to make sure adequate levels of all essential nutrients are present so multi-step



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biochemical pathways can function through to completion.”<sup>[1]</sup> In addition to vitamin C, niacin, and vitamin D,<sup>[2,3]</sup> the sulfur-containing amino acid cysteine and the selenium containing amino acid selenocysteine are necessary for immune function and wellness.<sup>[4]</sup> Garlic and onions are the richest sources of organosulfur compounds in the human diet. They also contain bioavailable selenium, while cruciferous vegetables such as broccoli are rich sources of bioavailable selenium.

## History of Garlic Use

Throughout recorded history, garlic has been valued for its medicinal properties. Across the centuries and on many continents, garlic has been associated with courage, strength, protecting against evil spirits and rabid animals, and curing coughs and colds. The ancient Egyptian, Babylonian, Roman, and Chinese healers may have been on the right track to connect garlic with healing and wellness. And, reflecting the notable persistence of these cultural associations, Bram Stoker’s fictitious character, Dr. Von Helsing, recommended garlic to prevent the return of Count Dracula in the horrific novel in 1897. Modern clinical studies side with the ancients in support of garlic having real health benefits. Aged garlic extract (600 – 1500 mg) has been shown to reduce blood pressure as effectively as medication.<sup>[5]</sup> Further, three doses of garlic per day effectively reduced the symptoms of lead toxicity.<sup>[6]</sup> Additionally, anti-bacterial properties, and even anti-cancer properties, of garlic are well supported, likely because of its generous content of organosulfur compounds.<sup>[7,8,9]</sup>

## Food Sources of Cysteine and Selenocysteine

Garlic belongs to a group of vegetables known as alliums. Onions and shallots also belong to this group. These vegetables are the richest sources of organosulfur compounds in the human diet, and also contain many other vitamins and trace minerals. Thirty-three different sulfur compounds have been identified in garlic, including allicin, diallyl disulfide, and s-allyl cysteine. A serving of garlic also contains about 1% of the daily requirement of selenium in the highly bioavailable form of methyl-selenocysteine (MSC or SeMSC), along with manganese, fiber, and vitamins C and B6. Similarly, onions contain many bioavailable sulfur compounds, along with vitamins C, B6, and B9, anthocyanins, quercetin, methyl-selenocysteine, and fructans (prebiotic fibers that feed helpful gut bacteria). Yellow onions contain 10 times more antioxidants than white onions. Methyl-selenocysteine along with manganese, and vitamins C and B9 are also prominent in broccoli and other cruciferous vegetables, including Brussels sprouts, cauliflower, and kale.

Supplemental sources of cysteine include alpha lipoic acid and N-acetyl-L-cysteine (NAC). Effective supplemental sources of selenocysteine include selenium yeast and Se-methyl-selenocysteine (SeMSC). Compared to selenocysteine, selenomethionine is abundant in nature, but is less helpful. Selenomethionine is randomly incorporated into proteins in place of methionine, which makes it unavailable for incorporation into selenium-containing enzymes where it is needed. This is not a trivial academic point. Clinical cancer studies using selenomethionine yielded negative results, while those using MSC produced positive results. Alliums and crucifers are unique in many ways, including their ability to produce SeMSC.

Traci Komorek, RD provides an introduction to incorporating alliums and crucifers into your diet in this 5 minute video: <https://anticancerlifestyle.org/cruciferous-vegetables-and-alliums-everything-you-need-to-know>.

## Basic Biochemistry of Cysteine and Selenocysteine

Sulfur is an important mineral in the body. Sulfur compounds are important to human health due to direct interactions with pathogens and tumor cells, and also as a vital source in the biosynthesis of the two sulfur-containing amino acids: methionine and cysteine. Thiamine (vitamin B1) and biotin (vitamin H) also contain sulfur. The most abundant sulfur-containing molecule in humans is glutathione (GSH), which is synthesized from glutamate, cysteine, and glycine. Glutathione is the main antioxidant inside cells. It works with glutathione peroxidases (GPx) within cells to convert hydrogen peroxide into water, and to neutralize other oxides and toxins. Glutathione is oxidized into glutathione disulfide (GSSG) in the process ( $2\text{GSH} + \text{H}_2\text{O}_2 \rightarrow \text{GSSG} + 2\text{H}_2\text{O}$ ). GSSG is recycled back to its reduced form GSH through a pathway that involves vitamin C and NADPH. In turn, GSH and GPx recycle oxidized vitamin C (DHAA) back to its reduced form (AA).<sup>[10]</sup>

Glutathione has been called the master intracellular antioxidant because of its major role in many redox pathways, and it has been positively associated with human longevity.<sup>[11,12]</sup> However, it is important to remember the interdependencies and synergies of nutrients require adequate presence of compounds necessary for each step of each biochemical pathway for optimal health. Furthermore, biochemical individuality and the unique stresses faced at any given time may result in unique biochemical weak points

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from person to person and within the same person across time. In addition to the direct interdependence of GSH and vitamin C, GSH and vitamin D also depend on one another for optimal expression and function. When GSH levels fall, vitamin D levels fall; and vitamin D levels can be enhanced by increasing cysteine and GSH.<sup>[13]</sup>

Replacing the sulfur

atom in cysteine with selenium is the difference between cysteine and selenocysteine.<sup>[14]</sup> GPx and other selenoproteins are one thousand times more efficient because of this single atom substitution.

Selenocysteine-containing proteins can also withstand greater levels of oxidation than their cysteine counterparts. Together, glutathione and selenoproteins make a strong intracellular defense network against excess oxidation. This is important because cellular oxidation leads to tissue inflammation which leads to organ dysfunction and disease. Similarly, injury including trauma or ischemia leads to tissue inflammation which leads to cellular oxidation. There are 25 known selenoproteins important to humans with at least seven different selenoproteins involved in protecting the cellular endoplasmic reticulum from excess oxidation.

Healthy cells, and a healthy blood circulation maintain a reductive state. Many diverse diseases including asthma, acute respiratory distress syndrome, beta thalassemia, cystic fibrosis, sickle cell disease, some cancers, ischemic heart disease, and serious viral infections including Covid-19 have been shown to shift the redox balance from a reductive state to an oxidative state.<sup>[15-18]</sup> After studying kidney, cardiovascular, and neurological function in over 150,000 patients with “long Covid”, Dr. Al-Aly concluded, “You can start thinking about getting COVID as almost an accelerant to aging. The viral infection accelerates the aging process in people.”<sup>[19-22]</sup> A solid nutritional foundation, including vitamins C and D, niacin, cysteine, and selenocysteine can help shift the body back towards a reductive state. Selenoproteins are also involved in immune function, protecting nucleic acids (DNA and RNA), and maintaining healthy coagulation – anticoagulation balance through interactions with von Willebrand factor and endothelial cells.<sup>[22-25]</sup>

## Conclusion

The risk of infections and chronic disease is ubiquitous to all humans. Therefore, it is important to maintain adequate nutrition, including adequate cysteine and selenocysteine intake, increasing intake as necessary in proportion to the level of disease. Solid nutritional support, adequate quality sleep and exercise, and a positive grateful attitude help us move forward through a world filled with challenges.

To enhance cysteine and selenocysteine levels:

*Foods:* garlic, yellow onions, cruciferous vegetables, including kale, collards, Brussels sprouts, broccoli, cauliflower.

*Supplements,* suggested adult doses:

- Vitamin C: 500-1000 mg, 3 times daily (more to bowel tolerance if sick)
- Vitamin D3: 5000 IU/day (maintain plasma vitamin D level in the 40 – 80 ng/ml range)
- Vitamin K2: 100 mcg/d
- Magnesium: 400 mg/d (in malate, citrate, chelate, or chloride form)
- Niacin / niacinamide: 200 – 1000 mg/day (start with low divided doses and gradually increase)
- Zinc: 20 mg/day
- Alpha Lipoic Acid: 300 mg/d
- Copper: 2 mg/day (along with Zinc, in chelates orotate, or gluconate form)
- Selenium: 100-200 mcg/day, as selenium yeast, or Se-methyl-L-selenocysteine

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