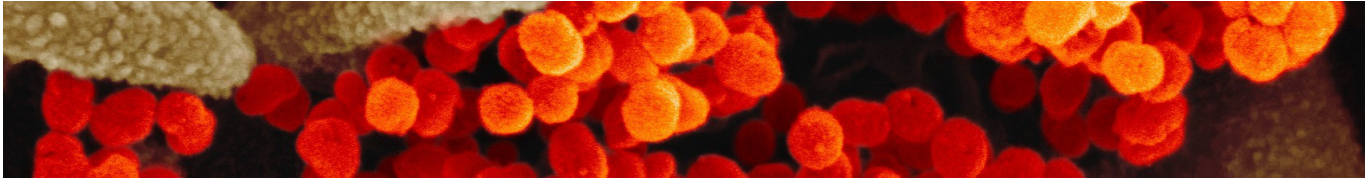


# Good Nutrition is Antiviral



Marjorie Roswell [Follow](#)

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Microscopy image excerpt showing novel Coronavirus isolated from a patient. Credit: NIAID-RML | License

This week one of my elected officials sent out a lengthy COVID-19 resource guide — including the requisite links to the local health department, the CDC page, and a list of closings. In one accompanying photo, he is standing in front of the *Oreo* shelf of the grocery store. A second photo features him in the *hot dog* aisle, doing a happy elbow bump with a member of a food workers local union. In the last photo he and his mom stride in a long view of the *Nabisco products* aisle.

That “health” messenger seems oblivious to the research revealing that **produce, spices, and beans are antiviral** and that **nutritional inadequacy leads to more virulent forms of infection**.

He’s not the only one to miss the critical role of diet to help (or harm) us in this time. Literally none (0.0%) of the public health messaging on coronavirus that has deluged my inbox mentions the role of good nutrition in boosting our immune system — our body’s defense against pathogens.

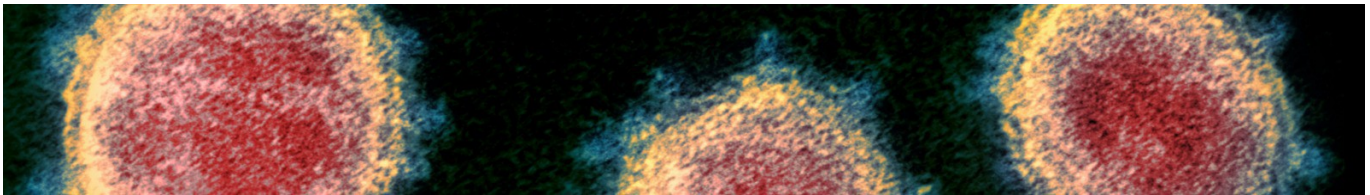
I’ve compiled and annotated a list of nutrition science references below, covering the antiviral (and pro-virulence) properties of various foods. The takeaways: **recognize the healing power** of green vegetables, mushrooms, berries, onions, garlic, ginger, beans, herbs, spices, and seaweed in our diet — and **avoid** foods that AGE us (that are high in *Advanced Glycation End products*, such as sugar, bacon, butter, cheese, fried chicken, and hot dogs).

If you can think of a way to expand the reach of this message, let me know. And if you can manifest those ways, all the better.

We have considerable power to protect ourselves from the ravages of this virus —and many other health threats at the same time.

## Annotated References for Antiviral Properties of Food

PubMed links are provided when available. Full-text article links are provided when articles are free.

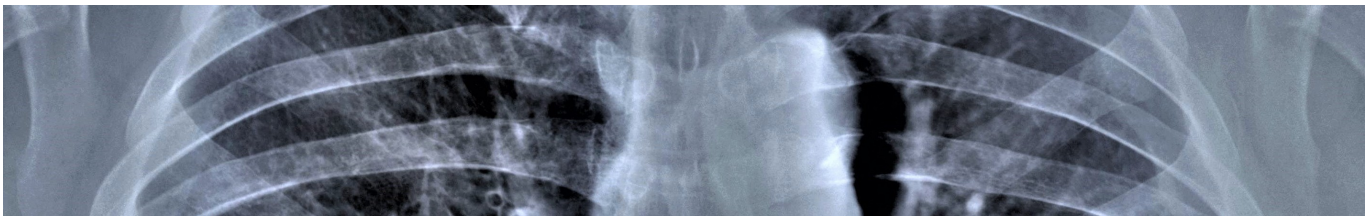


Microscopy image excerpt showing novel Coronavirus isolated from a patient. Credit: NIAID-RML | License

There is a remarkably close concordance between host nutritional status and immunity. Nutritional deficiencies affect both the host and the invading pathogen. **Nutritional inadequacy leads to more virulent forms of infection.**

- Beck MA, Handy J, Levander OA. **Host nutritional status: the neglected virulence factor.** *Trends Microbiol.* 2004;12(9):417–23.  
PubMed | Full-text article
- Keusch GT. The history of nutrition: malnutrition, infection and immunity. *J Nutr.* 2003;133(1):336S-340S.  
PubMed | Full-text article
- Beck MA. Antioxidants and viral infections: host immune response and viral pathogenicity. *J Am Coll Nutr.* 2001;20(5 Suppl):384S-388S.  
PubMed
- Levander OA. Nutrition and newly emerging viral diseases: an overview. *J Nutr.* 1997;127(5 Suppl):948S-950S.  
PubMed | Full-text article





**Micronutrient deficiencies** contribute to the mortality and morbidity of infectious diseases. Viral and bacterial infections are often associated with deficiencies in **essential trace elements**, such as **selenium and zinc**.

- Steinbrenner H, Al-quraishy S, Dkhil MA, Wunderlich F, Sies H. Dietary selenium in adjuvant therapy of viral and bacterial infections. *Adv Nutr*. 2015;6(1):73–82.  
PubMed | Full-text article
- Taylor CE, Higgs ES. Micronutrients and infectious diseases: thoughts on integration of mechanistic approaches into micronutrient research. *J Infect Dis*. 2000;182 Suppl 1:S1–4.  
PubMed | Full-text article
- Girodon F, Galan P, Monget AL, et al. Impact of trace elements and vitamin supplementation on immunity and infections in institutionalized elderly patients: a randomized controlled trial. MIN. VIT. AOX. Geriatric Network. *Arch Intern Med*. 1999;159(7):748–54.  
PubMed | Full-text article



**We evolved to eat green vegetables, not just for calories, but for immune protection as well.** The body's surfaces form a 400-square-meter protective interface with the external environment. These epithelial barriers are also colonized by a controlled diversity of microorganisms — and disturbances to the epithelial microbiome can give rise to disease.

Specialized immune cells called “intraepithelial lymphocytes” (IELs) are important as a first line of defense. The **aryl hydrocarbon receptor (AhR)** is a transcription factor that regulates gene expression, and functions as a crucial regulator in maintaining IEL numbers in both the skin and the intestine. Specific dietary compounds present in **cruciferous vegetables** act through this AhR to promote intestinal immune function, revealing the receptor as a critical link between diet and immunity. The specialized lymphocytes actually disappear in the absence of plant-derived dietary compounds. See the excellent 4-minute video that accompanies the first article below.

- Li Y, Innocentin S, Withers DR, et al. Exogenous stimuli maintain intraepithelial lymphocytes via aryl hydrocarbon receptor activation. *Cell*. 2011;147(3):629–40. PubMed | Full-text article | Video download (4:17)
- Hooper LV. **You AhR what you eat: linking diet and immunity.** *Cell*. 2011;147(3):489–91. (My favorite journal article name!) PubMed | Full-text article



The dietary intake of **mushrooms** significantly accelerates secretion of antibodies called secretory immunoglobulin A. These antibodies confer many health benefits, including **preventing viruses from binding to respiratory epithelial cells.**

- He X, Fang J, Guo Q, et al. Advances in antiviral polysaccharides derived from edible and medicinal plants and mushrooms. *Carbohydr Polym*. 2020;229:115548. PubMed
- Krupodorova T, Rybalko S, Barshteyn V. Antiviral activity of *Basidiomycete mycelia* against influenza type A (serotype H1N1) and herpes simplex virus type 2 in cell culture. *Virolog Sin*. 2014;29(5):284–90. PubMed

- Jeong SC, Koyyalamudi SR, Pang G. Dietary intake of *Agaricus bisporus* white button mushroom accelerates salivary immunoglobulin A secretion in healthy volunteers. *Nutrition*. 2012;28(5):527–31.  
PubMed
- Lindequist U, Niedermeyer TH, Jülich WD. The pharmacological potential of mushrooms. *Evid Based Complement Alternat Med*. 2005;2(3):285–99.  
PubMed | Full-text article



There is a positive relationship between antiviral activity and polyphenol content of a variety of **berries**.

- Sekizawa H, Ikuta K, Mizuta K, Takechi S, Suzutani T. Relationship between polyphenol content and anti-influenza viral effects of berries. *J Sci Food Agric*. 2013;93(9):2239–41.  
PubMed



Some berries get studied more than others. For instance: **Elderberry extract** stimulates immune response, preventing flu and other respiratory viruses.

- Kinoshita E, Hayashi K, Katayama H, Hayashi T, Obata A. Anti-influenza virus effects of elderberry juice and its fractions. *Biosci Biotechnol Biochem*. 2012;76(9):1633–8.  
PubMed | Full-text article

- Zakay-rones Z, Varsano N, Zlotnik M, et al. Inhibition of several strains of influenza virus in vitro and reduction of symptoms by an elderberry extract (*Sambucus nigra* L.) during an outbreak of influenza B Panama. *J Altern Complement Med.* 1995;1(4):361–9.  
PubMed



**Garlic** extract inhibits the coronavirus Infectious Bronchitis Virus in chicken embryos. Garlic is also delicious to (most) humans. The effect applies to other *Allium* species, including onions, leek, shallot, scallion, and chives.

- Mohajer shojai T, Ghalyanchi langeroudi A, Karimi V, Barin A, Sadri N. The effect of *Allium sativum* (Garlic) extract on infectious bronchitis virus in specific pathogen free embryonic egg. *Avicenna J Phytomed.* 2016;6(4):458–267.  
PubMed | Full-text article
- Kothari D, Lee WD, Niu KM, Kim SK. The Genus as Poultry Feed Additive: A Review. *Animals (Basel).* 2019;9(12)  
PubMed | Full-text article



The ginger family of plants comprises over 1300 species. Its most well-known members are **ginger** and **turmeric**. Curcumin (a plant derivative of turmeric) and fresh ginger are

well-studied, and proven to be antiviral. The effect spans virus families that are both genetically and functionally diverse. In a study of one common respiratory virus, the effect only worked with fresh, not dried ginger.

- Chang JS, Wang KC, Yeh CF, Shieh DE, Chiang LC. Fresh ginger (*Zingiber officinale*) has anti-viral activity against human respiratory syncytial virus in human respiratory tract cell lines. *J Ethnopharmacol.* 2013;145(1):146–51.  
PubMed
- Jassim SAA, Naji MA. Novel antiviral agents: a medicinal plant perspective. *Journal of Applied Microbiology.* 2003;95(3):412–427.  
PubMed | Full-text article



Chickpea (*Cicer arietinum*)

SARS-CoV-2 infection can be blocked by a clinically-proven **protease inhibitor**. Companies develop and sell protease inhibitor *drugs*. But what if we could get this virus protection from ordinary *beans* (soybeans, mung beans, chickpeas, etc.) and herbs (pea shoots and astragalus)? I'm proposing more research on this subject. We already know that protease inhibitors are widely distributed in legumes... and that beans are the most important dietary predictor of survival.

- Hoffmann M, Kleine-weber H, Schroeder S, et al. SARS-CoV-2 Cell Entry Depends on ACE2 and TMPRSS2 and Is Blocked by a Clinically Proven Protease Inhibitor. *Cell.* 2020;S0092–8674(20)30229–4.  
PubMed | Full-text article
- Meyer M, Jaspers I. Respiratory protease/antiprotease balance determines susceptibility to viral infection and can be modified by nutritional antioxidants. *Am J*

*Physiol Lung Cell Mol Physiol.* 2015;308(12):L1189–201.

PubMed | Full-text article

- Hafidh RR, Abdulmir AS, Abu bakar F, Sekawi Z, Jahansheri F, Jalilian FA. Novel antiviral activity of mung bean sprouts against respiratory syncytial virus and herpes simplex virus -1: an in vitro study on virally infected Vero and MRC-5 cell lines. *BMC Complement Altern Med.* 2015;15:179.  
PubMed | Full-text article
- Darmadi-blackberry I, Wahlqvist ML, Kouris-blazos A, et al. **Legumes: the most important dietary predictor of survival in older people of different ethnicities.** *Asia Pac J Clin Nutr.* 2004;13(2):217–20.  
PubMed | Full-text article
- Birk Y. Protein proteinase inhibitors in legume seeds — overview. *Arch Latinoam Nutr.* 1996;44(4 Suppl 1):26S–30S.  
PubMed
- Billings PC, Longnecker MP, Keary M, Taylor PR. **Protease inhibitor content of human dietary samples.** *Nutr Cancer.* 1990;14(2):85–93.  
PubMed



**Phytochemicals** refer to a wide group of compounds found in plants. Their biological properties include antioxidant activity, modulation of detoxification enzymes, stimulation of the immune system, decrease of platelet aggregation, and modulation of hormone metabolism.

- Zakaryan H, Arabyan E, Oo A, Zandi K. Flavonoids: promising natural compounds against viral infections. *Arch Virol.* 2017;162(9):2539–2551.  
PubMed | Full-text article



- Castilla V, Ramírez J, Coto CE. Plant and animal steroids a new hope to search for antiviral agents. *Curr Med Chem*. 2010;17(18):1858–73.  
PubMed
- Carratù B, Sanzini E. [Biologically-active phytochemicals in vegetable food]. *Ann Ist Super Sanita*. 2005;41(1):7–16.  
PubMed



In the study below,, serum  **$\alpha$ -carotene** concentrations were inversely associated with risk of death from all causes, CVD, cancer, and all other causes. **This study supports increasing fruit and vegetable consumption as a means of preventing premature death.**

- Li C, Ford ES, Zhao G, Balluz LS, Giles WH, Liu S. Serum  $\alpha$ -carotene concentrations and risk of death among US Adults: the Third National Health and Nutrition Examination Survey Follow-up Study. *Arch Intern Med*. 2011;171(6):507–15.  
PubMed | Full-text article



Piperamides are pungent bioactive organic compounds found in peppercorns. Scientists detected antiviral effects from piperamides isolated from **black pepper**.

- Mair CE, Liu R, Atanasov AG, Schmidtke M, Dirsch VM, Rollinger JM. Antiviral and anti-proliferative in vitro activities of piperamides from black pepper. *Planta Med* 2016; 82(S 01): S1-S381.

*Full-text article*



Avian infectious bronchitis is a widely-studied coronavirus because of its economic impact on the poultry industry. **Herb extracts from hyssop, oregano, peppermint, sage, and thyme were found to kill the virus and inhibit viral replication.** These effects were significant both prior to, and during infection. Across cultures, traditional healers have long used herbs to treat people. Science is beginning to catch up — with many herbs showing antiviral activity in humans, but more study is called for.

- Lelešius R, Karpovaitė A, Mickienė R, et al. In vitro antiviral activity of fifteen plant extracts against avian infectious bronchitis virus. *BMC Vet Res*. 2019;15(1):178. PubMed | Full-text article
- Dhama K, Karthik K, Khandia R, et al. Medicinal and Therapeutic Potential of Herbs and Plant Metabolites / Extracts Countering Viral Pathogens — Current Knowledge and Future Prospects. *Curr Drug Metab*. 2018;19(3):236–263. PubMed
- Akram M, Tahir IM, Shah SMA, et al. Antiviral potential of medicinal plants against HIV, HSV, influenza, hepatitis, and coxsackievirus: A systematic review. *Phytother Res*. 2018;32(5):811–822. PubMed





Studies demonstrate significant antiviral activity by various **seaweeds** against dengue, hepatitis C, herpes, HIV, influenza, and respiratory syncytial virus (RSV) and other viruses. Seaweed contains polysaccharides (long chains of carbohydrate molecules), which block viruses from attaching to host cells, and even prevent viruses from replicating.

- Shi Q, Wang A, Lu Z, Qin C, Hu J, Yin J. Overview on the antiviral activities and mechanisms of marine polysaccharides from seaweeds. *Carbohydr Res*. 2017;453–454:1–9.  
PubMed
- Gheda SF, El-adawi HI, El-deeb NM. Antiviral Profile of Brown and Red Seaweed Polysaccharides Against Hepatitis C Virus. *Iran J Pharm Res*. 2016;15(3):483–491.  
PubMed | Full-text article
- Ahmadi A, Zorofchian moghadamtousi S, Abubakar S, Zandi K. Antiviral Potential of Algae Polysaccharides Isolated from Marine Sources: A Review. *Biomed Res Int*. 2015;2015:825203.  
PubMed | Full-text article
- Wang W, Wang SX, Guan HS. The antiviral activities and mechanisms of marine polysaccharides: an overview. *Mar Drugs*. 2012;10(12):2795–816. PubMed | Full-text article
- Harden EA, Falshaw R, Carnachan SM, Kern ER, Prichard MN. Virucidal activity of polysaccharide extracts from four algal species against herpes simplex virus. *Antiviral Res*. 2009;83(3):282–9.  
PubMed | Full-text article
- Wang H, Ooi EV, Ang PO. Antiviral activities of extracts from Hong Kong seaweeds. *J Zhejiang Univ Sci B*. 2008;9(12):969–76.  
PubMed | Full-text article





Free radicals are unstable molecules produced during normal cell metabolism. A **low antioxidant intake** impairs the patient's ability to scavenge free radicals, yielding damage to DNA, RNA, proteins, lipids, and cell membranes. Free radicals generated in excess of a cell's antioxidant capacity (oxidative stress) may even cause cell death. Antioxidants are found in fruits and vegetables. The presence of antioxidants in fruits and vegetables warrants nutritional approaches to activating the immune system and alleviating disease symptoms.

- Puertollano MA, Puertollano E, De cienfuegos GÁ, De pablo MA. Dietary antioxidants: immunity and host defense. *Curr Top Med Chem.* 2011;11(14):1752–66.  
PubMed
- Wood LG, Gibson PG. Dietary factors lead to innate immune activation in asthma. *Pharmacol Ther.* 2009;123(1):37–53.  
PubMed
- Peterhans E. Oxidants and antioxidants in viral diseases: disease mechanisms and metabolic regulation. *J Nutr.* 1997;127(5 Suppl):962S-965S.  
PubMed | Full-text article



Increasing high fructose corn syrup-sweetened **soft drink consumption** is significantly correlated with adult chronic bronchitis.

- Dechristopher LR, Uribarri J, Tucker KL. Intake of high fructose corn syrup sweetened soft drinks is associated with prevalent chronic bronchitis in U.S. Adults, ages 20–55 y. *Nutr J.* 2015;14:107.  
PubMed | Full-text article



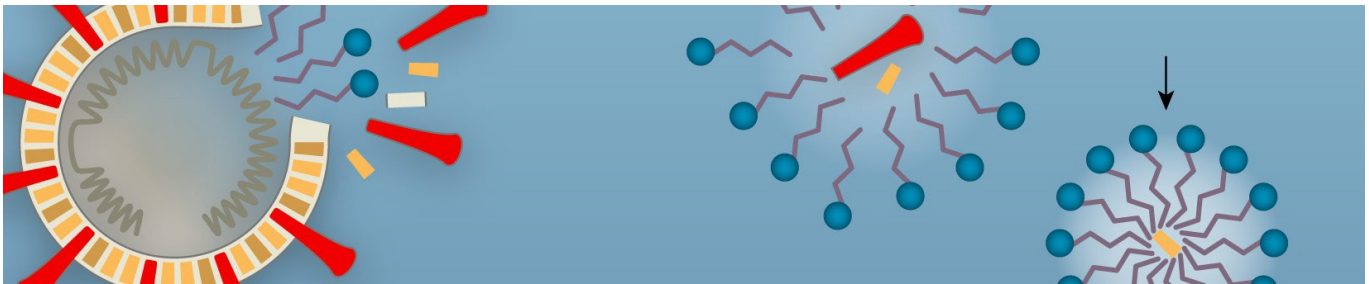
**Advanced glycation end products (AGEs)** are formed when sugars react with and permanently alter proteins or fats. Although most people haven't heard of them, they **have profound, documented negative effects on overall health.**

While AGEs can be formed inside the body as a result of our metabolism, there are also dietary AGEs, which are measured in units called *kilounits (kU)*. On average we consume a high level: 15,000 kU per day. One hundred grams of tomato has 23 kU. One hundred grams of frankfurter contains between 7,484–11,270 kU. (Two Hebrew National hot dogs would be 98 grams.) See Uribarri, Woodruff, et al., which provides a table showing AGE levels of more than 500 foods.

New research published in February 2020 looks at the impact of AGEs on the immune system, and proposes specific approaches for further research. For a good introduction to AGEs, watch Dr. David Turner's excellent TEDx talk.

- Almajwal AM, Alam I, Abulmeaty M, Razak S, Pawelec G, Alam W. Intake of dietary advanced glycation end products influences inflammatory markers, immune phenotypes, and antiradical capacity of healthy elderly in a little-studied population. *Food Sci Nutr.* 2020;8(2):1046–1057.  
PubMed | Full-text article
- TEDxCharleston. (2019, July 31). *David Turner: Do you know what AGEs are?* [Video file]. Retrieved from <https://youtu.be/LvwMXqyrKGO>

- Chen JH, Lin X, Bu C, Zhang X. Role of advanced glycation end products in mobility and considerations in possible dietary and nutritional intervention strategies. *Nutr Metab (Lond)*. 2018;15:72.  
PubMed | Full-text article
- Uribarri J, Woodruff S, Goodman S, et al. Advanced glycation end products in foods and a practical guide to their reduction in the diet. *J Am Diet Assoc*. 2010;110(6):911–16.e12.  
PubMed | Full-text article



For good measure, here is some terrific information from the *New York Times* about how coronavirus hijacks our cells, and why soap helps.

- How Coronavirus Hijacks Your Cells  
<https://www.nytimes.com/interactive/2020/03/11/science/how-coronavirus-hijacks-your-cells.html>
- Why Soap Works  
<https://www.nytimes.com/2020/03/13/health/soap-coronavirus-handwashing-germs.html>

## Notes

- Our immune systems have extraordinary complexity and capacity. We need to give it the right nutrients to keep it intact.
- Roughly half of all produce in the United States gets thrown away.
- The adoption of an immune-system-supporting diet faces many barriers. To begin with, many communities (low-income, rural, incarcerated, etc.) have long-lacked

access to healthful food. Lack of public health messaging on the profound benefits of a healthful diet should not be one of the barriers.

## **Conclusion**

The coronavirus crisis may make you feel helpless and scared. What if you knew of simple ways to protect yourself? We all eat every day. Choosing foods with antiviral properties — and avoiding harmful foods — can help protect ourselves and our communities from the bodily ravages of this virus. This form of prevention and healing needs to be part of our public health messaging during this crisis.

Wash your hands with soap. Practice social distancing for the sake of our healthcare system. AND eat healthful food to have the best chance of fighting off infection and staying well. So far only two of these three messages are routinely shared by public health and elected officials. Please help to change that. Please get to know this content, and share it with others.