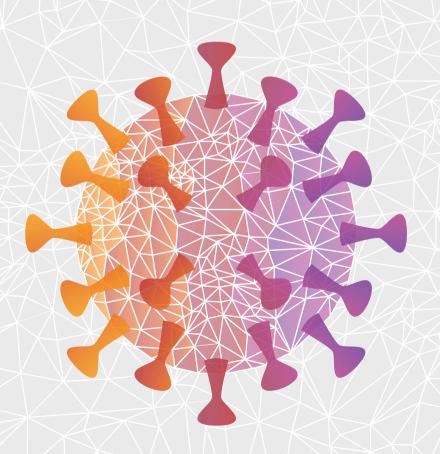
Teemu Arina, Olli Sovijärvi & Siim Land

BIOHACKER'S FLU GUIDE

FORTIFYING YOURSELF AGAINST PATHOGENS



Biohacker's Flu Guide: Fortifying Yourself Against Pathogens

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INTRODUCTION

The world has turned into a giant petri dish for brewing potential pathogens that can wreak havoc on our health, productivity and wellbeing. With increased travel, both bacterial and viral infections can spread far and wide in a short period of time. Mass production of food brings infectious agents, animals and humans closer to each other, creating the conditions for an infection crossing the species barrier (so-called *zoonotic diseases*). Globally-integrated logistics of food, goods and people adds a vector through which germs can spread from one country or continent to another at record speed.

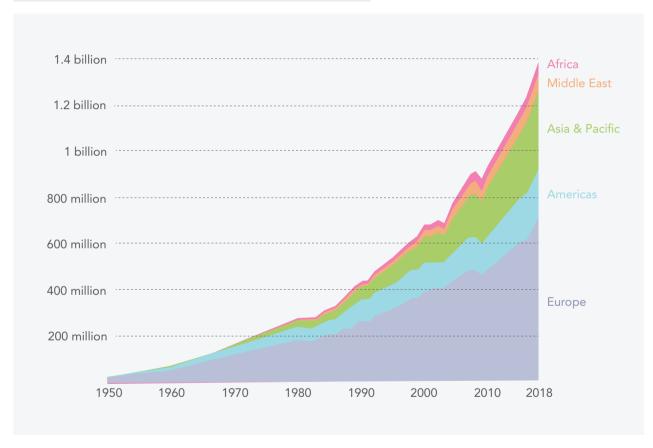
The world has changed, and human-migration is easier than ever. For example, Chinese Lunar Year or "Chunyun" is the world's largest annual migration event involving 2.99 billion trips (2020 estimate). Of those, 2.43 billion trips are made by automobile, 440 million by rail, 79 million by air and 45 million by sea. Epidemics are increasingly common and the likelihood of encountering a potentially lifethreatening infectious disease in one's lifetime is still worth

a concern, even if one doesn't travel to exotic places and always remembers to wash hands before eating.

Luckily, modern times bring modern responses to epidemics: outbreaks are identified much more quickly, disease agents are identified at record speed, epidemics get contained quickly and treatments are developed faster. Modern technology, medicine and healthcare all have reduced the likelihood of death significantly, open research has accelerated our collective understanding, and improved hygiene has reduced transmission of diseases for the benefit of the survival of our species.

In the near future, the potential still remains for a global highly contagious pandemic that can be resistant to existing treatments such as antivirals and antibiotics. This is why preparedness is not just wise but recommended. Epidemics are commonplace, and novel threats include the potential for antibiotic-resistant bacterial strains, novel diseases crossing the species barrier, outbreaks at farms and markets and even bioengineered pathogens escaping laboratories.

INTERNATIONAL TOURIST ARRIVALS BY WORLD REGION



Source: World Tourism Barometer (2019).1

LIST OF NOTABLE EPIDEMICS IN RECENT HISTORY

EPIDEMIC	AGENT	ТҮРЕ	YEAR	DEATHS
Black death	Plague	Bacteria	1331–1353	75–200 million (30–60 % of population)
Cocoliztli epidemic	Salmonella	Bacteria	1545–1580	7–17 million
Great plague	Plague	Bacteria	1738–1740	50 million
North American Smallpox Epidemic	Smallpox	Virus	1775–1782	30 % of population
Asiatic cholera pandemic	Cholera	Bacteria	1817–1837	100 000s
Typhus epidemic	Typhus	Virus	1847–1848	20 000
Flu pandemic	Influenza	Virus	1889–1890	1 million
Spanish flu	Influenza	Virus	1918–1920	100 million
Asian flu	Influenza	Virus	1957–1958	2 million
Hong Kong flu	Influenza	Virus	1968–1969	1 million

LIST OF NOTABLE EPIDEMICS IN RECENT HISTORY

EPIDEMIC	AGENT	TYPE	YEAR	DEATHS
HIV/AIDS pandemic	HIV	Virus	1960– present	> 30 million
SARS outbreak	SARS coronavirus	Virus	2002–2004	< 1000
2009 flu pandemic	Influenza	Virus	2009	203 000
Haiti cholera outbreak	Cholera	Bacteria	2010– present	10 000
Congo measles outbreaks	Measles	Virus	2011– present	< 10 000
Ebola West Africa	Ebola	Virus	2013–2016	> 11 000
Indian swine flu	H1N1	Virus	2015	> 2000
Wuhan coronavirus	Novel Coronavirus	Virus	2019– present	TBA

Looking at the history of epidemics, modern times have seen several close calls, but the number of deaths per epidemic remains relatively low compared to periods of war and pre-industrial times.

Source: Redrawn by authors. Original synthesis from Wikipedia, List of Epidemics (2020).

INCREASE AWARENESS AND GETTING PREPARED

It is important to become aware of various ways on how to become well-prepared from the inside-out. Here are the steps to increase awareness and get prepared for anything that happens in the environment:

1. PRECAUTION

Increase one's knowledge regarding various pathogens, biochemical basis of their infection mechanisms and potential means of mitigation.

2. PREPARATION

Prepare the internal environment (the body and the immune system) before possible contact with a potential disease agent to become more resistant and/or immune to it.

3. PREVENTION

Prepare ones external environment (the immediate surroundings) to reduce the likelihood of contracting a disease agent. This means diminishing the predispositition risk for example to a seasonal flu virus by doing preventive procedures such as practicing proper hand hygiene and avoiding contaminated areas.

4. ACTION

In an event of infection, slow down the proliferation of the disease agent, support the immune system in its adequate functioning, and avoid infecting others in the process.

5. RESPONSE

Speed up recovery, restore the balance of the body after the infection, and avoid the emergence of secondary diseases. Reflect on the experience, incubation period, symptoms and lessons learned.

TRANSMISSION & AMPLIFICATION OF ZOONOTIC DISEASES

Transmission of a pathogen to people can occur directly from a wild animal or following an outbreak in livestock that amplifies the likelihood of transmissions to humans. The ongoing disease transmission from animals to people presents a significant global health burden. Based on a 2015 scientific review, animal-to-human spillover of new viruses that are capable of infecting diverse host species signal emerging disease events with higher pandemic potential. These viruses are more likely to amplify by human-to-human transmission on a global scale. The burden is particularly relevant in areas where dense human populations and pressures on environmental and economic resources are greatest, such as in China and Africa. Annually, over one billion cases of human zoonotic disease are estimated to occur.²

The majority (94 %) of zoonotic viruses described to date are RNA viruses, which is 28 times higher than the proportion of RNA viruses among all vertebrate viruses recognized, indicating that RNA viruses are far more likely to be zoonotic than DNA viruses.³ In general, wild animals are the source of zoonotic transmission for 91 % of zoonotic viruses compared to 34 % of viruses transmitted from domestic animals, and 25 % with transmission described from both wild and domestic animals.

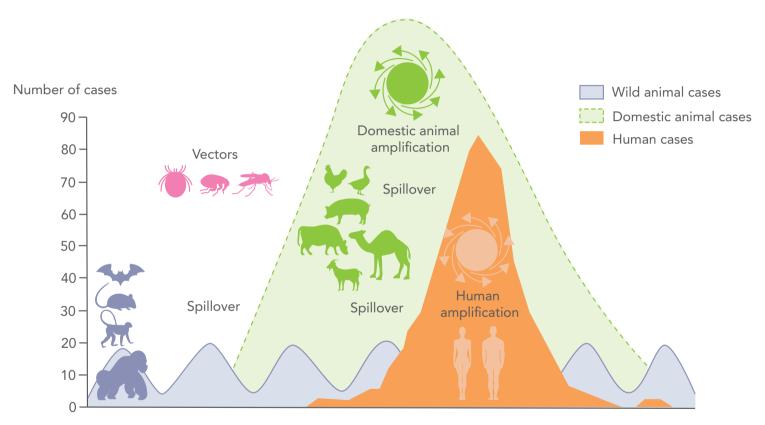
Once animal viruses have spilled over into humans, human-to-human transmission of *zoonoses* facilitates sustained spread of disease with a rapidity and reach impossible for zoonotic viruses requiring only animal contact for the transmission. Hunting of high-risk host species carries an increased risk and even a probability of transmission of zoonotic viruses that can be further spread by human-to-human transmission.⁴

EXAMPLES OF ZOONOTIC VIRUSES

Virus	Wildlife source		
Rabies	Foxes, raccoons, bats		
MERS	Camels, bats		
Influenza	Birds, ducks		
SARS	Bats, palm civets		
Ebola	Monkeys, bats		
Hanta Viruses	Rodents		
Yellow Fever	Monkeys		
HIV/AIDS	Apes		
Hendra	Horses, fruit bats		
Novel Coronavirus	Bats		
Zika Virus	Aedes mosquitos		

Viruses can become deadly when they cross the species barrier: our biology has not had enough time to adapt and build innate immunity against such threats.

TRANSMISSION OF INFECTION AND AMPLIFICATION IN PEOPLE



Transmission of a pathogen to people can occur directly from a wild animal or following an outbreak in livestock, which amplifies the likelihood of transmissions to humans.

Source: Karesh, W. et al. (2012). Ecology of zoonoses: natural and unnatural histories. Lancet 380 (9857): 1936–1945. Review.⁵

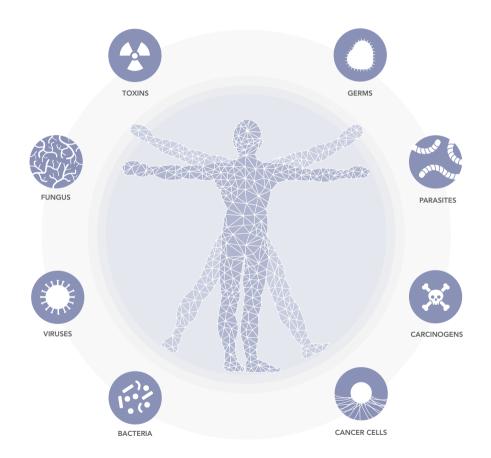
BASICS OF THE IMMUNE SYSTEM

The word "immunity" originates from the Latin word immunis, meaning exempt. Generally speaking, immunity consists of all of the body's defense systems that resist infections, toxins and foreign matter.

We have previously written the *Biohacker's Handbook* special issue <u>Invincible Immunity</u> (2017), from which you can learn more about the functioning of the human immune system in great detail. In this guide, we will focus primarily on bacterial and viral defense mechanisms in relation to the immune system.

For the purpose of this guide we provide a short summary. The immune system can be divided into two major parts:

1) Innate immunity is what a person is born with. It is also affected by the vaccinations received as well as the foreign matter and microbes the person is exposed to during their lifetime. Innate immunity functions quickly, effectively and consistently. It is mediated by antigenpresenting cells (APC), neutrophils, and general defense mechanisms such as the complement system.



2) Adaptive immunity is what a human being learns over a lifetime by exposing oneself to various pathogens. Its response is delayed by a few days as it scrambles for action. It can be divided into cell-mediated immunity and humoral (fluid-based) immunity. It is mediated by *T-cells* (killer and helper cells) and *B-cells* (that produce antibodies).

You may have noticed that sometimes your reaction to a pathogen may be asymptomatic (you may still spread it to others although you have no symptoms), mild (it goes away in a few days), or "full-on" pathogenic (noticeable and takes 1–2 weeks to resolve at minimum). This is due to individual differences in the immune system response and the fact that you may or may not have encountered the pathogen previously. Immune system is fast to react when it notices a familiar pathogen and can get rid of it in just a few days. If a pathogen is previously unknown, it takes a few weeks for the adaptive immune system to recognize, mark, and eliminate the intruder. Pathogens may also mutate, which makes it harder for the immune system to recognize a previously known pathogen. In some cases, a virus can also hide from the immune system and remain dormant until later activation (such as HIV, herpes, and papillomavirus).

Effective drugs can be developed to kill potential intruders (such as *antibiotics* against bacteria), inhibit their replication (such as *antivirals* against viruses), block their way into the system (such as *receptor antagonists*), and *vaccines* (where the immune system is taught with weakened viral agents with the aim to help it recognize the pathogen in the future).

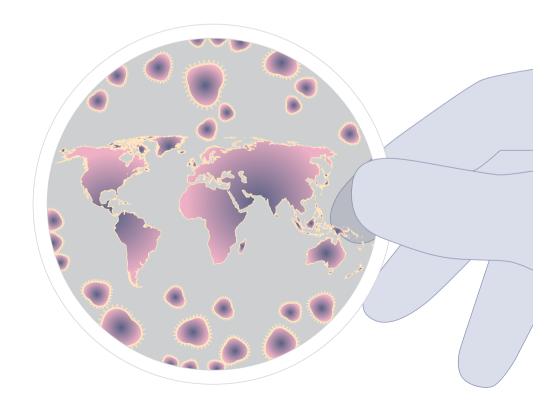
This guide focuses on strategies for building various barricades against intruders before they get the opportunity to take hold. The aim is to inhibit their proper functioning and make one more resistant to their effects.

We take no opinion on vaccination, as it is a controversial topic, although our recommendation is to do your own research, look into historical data, read scientific peer-reviewed journals and talk to specialists regarding actual risks and trade-offs. Fundamentalism does not serve intellectualism nor species survival.

It has been known for centuries that fevers and infections, especially in childhood, may actually be healthy, leading to better health outcomes as adults. A study published in 2019 found that children who contract influenza early in their lives receive strong immunity against potential mutated

subtypes of the influenza virus.⁶ However, in some cases you are out of luck, especially as an adult. For example, *measles* is known to wipe out the immune system memory leaving one vulnerable to other diseases,⁷ and the influenza virus may permanently damage the nervous system and increase the risk for Parkinson's disease.⁸ Infections therefore can be a double-edged sword: they can make us either stronger or weaker depending on the situation.

Microbiologists Louis Pasteur (1822–1895) and Robert Koch (1843–1910) believed you can either focus on external factors (such as germs) as the causative factor for disease or focus on the internal. The father of physiology, Claude Bernard (1813–1878), recognized the importance of "milieu interieur"—our internal environment as a doorway to a better health. Knowledge of both external and internal factors is the true virtue.



PREPARATION OF YOUR BODY WITH NUTRITIONAL INTERVENTIONS

Here are the body's biochemical defense systems that modulate the immune system and increase resilience against disease. Consider stimulating and upregulating the following physiological factors:

GLUTATHIONE (THE MASTER ANTIOXIDANT)

Glutathione is the body's main antioxidant defense mechanism produced in the liver. It protects against free radicals and helps to eliminate lipid peroxides as well as toxins. This is by far more powerful than antioxidant supplements or vitamins because the body will self-regulate glutathione's role in the immune system.^{9 10}

NRF2 PATHWAY

Nrf2 is one of the main regulators of antioxidants and cell protection. It promotes glutathione, NADPH, thioredoxin and other antioxidant pathways.¹¹

AUTOPHAGY (THE MAJOR CLEANING SYSTEM OF THE BODY)

Cellular self-eating modulates immunity and elimination of pathogens via autophagy. 12 The body recognizes damaged cells and recycles them. Autophagy gets

triggered in response to stress like infections, starvation, high exertion or certain compounds such as various phytochemicals. You can promote autophagy with positive stressors such as intermittent fasting, regular sauna, exercise and cold exposure.

URIC ACID

Uric acid is the most concentrated antioxidant in the human blood that helps to mitigate oxidative stress, especially at high altitudes and under hypoxia.¹³ In high amounts it can cause gout and fibromyalgia, but in low concentrations it is actually beneficial.¹⁴ You obtain it from purine-rich foods like organ meat, wild game, red meat and seafood.

NAD+ (THE KEY ENZYME IN EVERY CELL)

Nicotinamide adenine dinucleotide (NAD+) is a major cofactor that partakes in virtually all cellular reactions. It promotes energy production and enables cells to work properly. NAD+ deficiencies are linked to aging and disease. Low NAD+ is also known to inhibit the body's immune system and natural defense mechanisms.¹⁵

NADPH

Nicotinamide adenine dinucleotide phosphate (NADP+) is a cofactor for anabolic reactions such as cellular growth

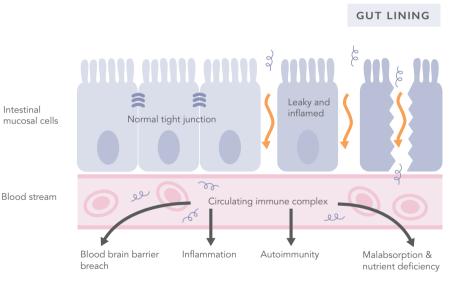
and nucleic acid synthesis. NADPH is the reduced form of NADP+. It protects against the oxidative stress from excessive reactive oxygen species (ROS) and allows for the regeneration of glutathione. 16 Oxidative stress arises in bacterial infections partly due to altered metabolic pathways and imbalances.¹⁷

STRONG GUT LINING

Intestinal permeability, or leaky gut, is associated with autoimmune diseases and the development of several inflammatory diseases. 18 19 Such disturbances have been linked to higher inflammatory biomarkers and weakened immunity. Higher low-level inflammation makes one more prone to infections.²⁰ Bone broth, tendons and ligaments have collagen and glycine, which promote tissue repair.²¹ Butyrate is also essential for feeding the colon. It's the main energy source for cells in the large intestine.²² You can get butyrate primarily from the fermentation of fiber, beans, and legumes but also from ghee and butter. Avoiding gluten and lectins, or at least limiting them, is a smart idea to protect the gut lining.²³

DIVERSITY OF THE GUT MICROBIOTA

Microbial diversity in the gut has been linked to stronger immunity.²⁴ This may be due to the role of microbes in our natural defense mechanisms. This is why probiotics and a diverse diet rich in foods that enrich the gut microbiota may be beneficial for boosting immunity. The ecosystem of microorganisms in our bodies can aid us in defense against pathogens.



Intestinal

NUTRIENTS RELEVANT TO THE IMMUNE SYSTEM

People who are malnourished are more vulnerable to infections and sickness because their immune system lacks the resources to function properly.²⁵ Studying diseases in countries of high poverty have highlighted the importance of nutrition and healthy functioning of the immune system. However, the Western world is not too far behind due to poor nutritional choices leading to potential deficiencies.²⁶

Correcting nutrient deficiencies is a useful strategy. Nutrition intervention in cases of vitamin D, zinc, iron and vitamin A, for example, have been shown to improve efficacy of preventing and treating pneumonia, especially in children.²⁷ If you have no deficiencies, benefits of supplementation may be limited.

Here are the most important micronutrients, vitamins and phytochemicals that support healthy functioning of the immune system:

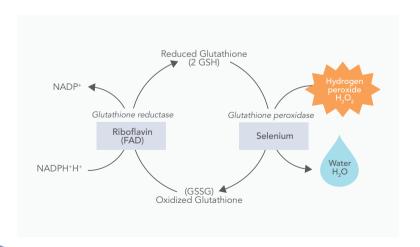
VITAMIN D

Vitamin D is central to the body's immune system. Low levels of vitamin D are associated with increased risk and prevalence for infections in multiple studies.²⁸ In one study among 19 000 subjects, people with lower vitamin D levels

were more likely to suffer from upper respiratory tract infections.²⁹ A 2012 study found that giving young children 1 200 IU of vitamin D a day reduced the risk of influenza.³⁰ Several systematic reviews of daily vitamin D supplementation have shown it to be protective against respiratory tract infections (RTIs).^{31 32}

SELENIUM

Selenium is an essential mineral that is a cofactor in glutathione production.³³ It is also important for hormonal balance, antioxidant defense redox signaling, and redox homeostasis (balancing the oxidative stress in the body). Viral infections frequently produce a higher number of reactive oxygen species (ROS).³⁴ When overwhelming the antioxidant defense system, the excess production of



ROS induces oxidative stress. ROS in turn can enhance viral replication. Viral infection then increases the need for certain micronutrients such as selenium in the antioxidant defense. Selenium deficiency has been linked to pathogenicity of several viruses³⁵ and lower survival from pneumonia due to influenza ³⁶

VITAMIN B3 (NIACIN)

Vitamin B3, or niacin, supplementation increases NAD+ biosynthesis.³⁷ Pharmacological doses of niacin may help the immune system fight against severe infections like HIV and tuberculosis, but the research is still preliminary.³⁸

VITAMIN C

- Vitamin C is an antioxidant that animals produce in response to stress.³⁹ Humans have lost that ability during our evolution and have to obtain it from diet. Vitamin C helps to recycle oxidized glutathione back into active glutathione.⁴⁰ Based on a large meta-analysis, regular intake of vitamin C has not been shown to prevent colds but it can shorten the duration of colds (by 8 % in adults and 14 % in children) with slightly less severe symptoms. Athletes who take vitamin C regularly are half as likely to catch a cold as athletes who don't.⁴¹
- A 1999 study done on 463 students showed that megadosing vitamin C may be helpful in treating the flu right after the appearance of flu symptoms with hourly doses

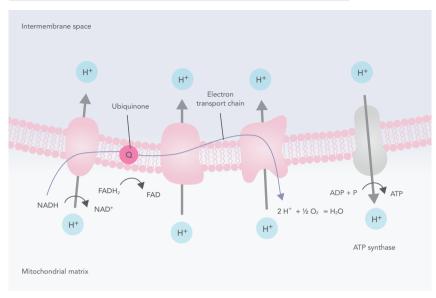
of 1000 mg of Vitamin C for the first 6 hours and then 3 times daily thereafter. Overall, reported flu and cold symptoms in the test group decreased 85 % compared with the control group after the administration of megadose Vitamin C.⁴² Nobel laureate, Linus Pauling, has said that as soon as you feel the symptoms of sniffles, a cold or the flu, taking oral doses of thousands of milligrams of vitamin C is helpful.⁴³

- In stressed mice, megadosing vitamin C helped to prevent from influenza (H1N1)-induced pneumonia⁴⁴
- A recent 2020 meta-analysis published on the Journal of Intensive Care showed that 1–6g of intravenous vitamin
 C per day shortened the ventilation time on patients needing intensive care on average by 25 %⁴⁵

UBIQUINONE (COENZYME Q10)

Ubiquinone (coenzyme Q10) acts as a contributor to the electron transport chain. It is a fat-soluble compound that helps to generate ATP (adenosine triphosphate) and hence energy. It has been used for decades as a dietary supplement. Low cellular ubiquinone levels may be a predisposing factor for various illnesses due to insufficient aerobic energy production in the cells. With low energy production the body will not be able to fight the intruders. Ubiquinone reduces oxidative stress and preserves macrophages in the immune system. 47

ROLE OF UBIQUINONE IN THE ENERGY PRODUCTION



Source: Biohacker's Handbook (2019).

ZINC

- In humans, zinc is required for the function of more than 300 enzymes and more than 1 000 transcription factors (proteins that regulate the function of genes). It acts in enzymatic reactions as a catalyst to accelerate the action of these.⁴⁸
- Zinc also plays an important role as a structural agent of proteins and cell membranes preventing oxidative stress.⁴⁹ Zinc is important for hormone production and immunity. It is also known for fighting against infections. Low zinc status in the body can cause gastrointestinal

- problems and increase the risk for pneumonia.⁵⁰ However, be reasonable with supplementation: very high zinc supplementation can cause toxicity and stomach pain.⁵¹
- Zinc acetate and zinc gluconate lozenges have been shown to inhibit cold viruses from latching onto the cells and shorten the duration of the flu. Lozenges are beneficial only in the early stages of infection. The optimal dose according to studies is 75–90 mg per day divided into multiple doses given 2–3 hours apart. Best results are gained when started within 24 hours of the first symptoms. ⁵² Do not exceed 100 mg of zinc per day for up to two weeks. Avoid nasal sprays, as they might cause a lingering loss of smell perception.
- Regular use of zinc may reduce the incidences of flu, at least in children. According to studies in children, regular use of zinc can prevent the flu.⁵³

NITRIC OXIDE

Nitric oxide (NO) is an important signaling molecule between cells and it has been shown to fight against some viral and bacterial infections.⁵⁴ Supplementation with NO boosters (for example L-arginine and L-citrulline as well as foods rich in nitrates such as beets and leafy greens) may inhibit viral replication cycles (e.g. SARS coronavirus).⁵⁵ Note that when used excessively, arginine can activate an underlying herpes infection when intake of L-lysine is also low.⁵⁶

TOP 3 MICRONUTRIENTS AND THEIR RECOMMENDATIONS: START FROM THESE



Vitamin D3

Vitamin D plays a key role in regulating the balance of the immune system. Vitamin D, for example, acts as a source of power for T-cells. Without vitamin D, T-cells never wake up from their dormancy, which leads to impaired immune system function. People with vitamin D deficiency are more likely to have the flu and colds.⁵⁷

Optimize your vitamin D3 levels either with getting enough sunlight or with supplementation. It is also crucial to know your blood levels of vitamin D3 by measuring them regularly. Only this way it is possible to implement the right dosages when doing supplementation. A 2014 study from the University of Cambridge found that human mortality was lowest when vitamin D3 levels (calcidiol) were at least 90 nmol/L.⁵⁸ Low vitamin D3 levels may be due to chronic low level inflammation.⁵⁹

Recommended values for the prevention of cardiovascular disease:⁶⁰

- Less than 50 nmol/L: deficiency
- 50–74 nmol/L: insufficient concentration
- 75–99 nmol/L: sufficient concentration
- 100–150 nmol/L: optimum concentration
- Above 375 nmol/L: toxic concentration

If you are using a nutritional supplement, measure the blood levels again after 3 months. This will help you assess how your vitamin D3 levels will change. For many, the recommended dose is 50–100 micrograms a day, but only if the level of vitamin D3 in the blood is low or is not at the target level (usually less than 70 nmol/L).

2. Zinc

Zinc is the first supplement to take immediately if you feel yourself even a little sick with any of the typical flu symptoms: running nose and nasal congestion, sore throat, headache, fatigue/ weakness, coughing, muscle ache and fever over 100.4 F (38 C).

The research shows that only certain forms of zinc are effective for the flu and common cold:

- Zinc acetate (take 15 mg 5–6 times per day as long as needed)⁶¹
 - Prefer a lozenge or sublingual spray
 - Take maximum of two weeks
- Zinc picolinate (take 18–23 mg every two hours during wake times since the onset of symptoms for as long as needed)⁶²
 - Prefer a lozenge
 - Take maximum of two weeks

3. Vitamin C.

The body is able to store 300–2 000 mg of vitamin C in itself. Vitamin C is stored throughout the body, but especially in white blood cells (in the immune system), eyes, adrenals, pituitary gland and the brain.⁶³ In times of disease and infections, in particular, the reserves are spent quickly for acute needs. Therefore, if you notice yourself catching the cold or even the flu (influenza), it is a wise decision to also begin taking big doses of vitamin C within 24 hours of the first symptoms (see above).⁶⁴

Take Vitamin C as follows:

- 1 000 mg every hour for the first 6 hours
- Then 1 000 mg 3 times daily for as long as needed

FOODS, SUPPLEMENTS AND HERBS RELEVANT FOR THE IMMUNE SYSTEM

Here are foods and specific supplements that have the potential to fortify the immune system against pathogens:



COLLAGEN

Collagen is an important building block in various immune system functions. For example, certain endogenous lectins such as *collectins* (collagen-containing C-type lectins) abundant in liver, lungs, placenta and kidney have been identified to mediate innate host defense against influenza virus infections and prevent secondary infections. ⁶⁵ Collectins are a vital part of the innate immune system in the lungs. ⁶⁶ Collectins are thought to recognize and interact preferentially with carbohydrate structures that are arranged in distinct patterns on the microbial cell surface. Collectins generally mediate pathogen clearance via complement activation and by aggregating cells together. ⁶⁷ This is beneficial for the immune system and pathogen killing.



LICORICE

Influenza virus infection is characterized by an acute lung inflammatory response (*hypercytokinemia*) and high oxidative stress that contributes to virus-induced lung damage and morbidity. *Isoliquiritigenin* (ILG) present in

licorice has been recognized as a potent inhibitor of influenza virus replication in human bronchial epithelial cells and an inhibitor of inflammatory cytokines. Administration of ILG reduces the morbidity of mice infected with the H1N1 virus. 68 *Glycyrrhizin*, an active compound of licorice root, has also been used to inhibit the replication of SARS-associated coronavirus. 69



LACTOFERRIN

Many studies have demonstrated the antiviral activity of lactoferrin against viral pathogens that cause common infections. 70 71 Lactoferrin consumption may protect the host from viral infections through inhibiting the attachment of a virus to the cells, replication of the virus in the cells and enhancement of systemic immune functions. 72 Lactoferrin-derived peptides are being researched as potent therapeutic inhibitors of influenza virus infections. 73 In addition, hydrolyzed whey protein, that contains many bioactive peptides, has been shown to induce macrophage activity (killing pathogens more effectively) and activate anti-inflammatory functions. 74



L-GLUTAMINE

• L-glutamine is the most abundant amino acid in the bloodstream and accounts for 30–35 % of the nitrogen content of amino acids in the blood. The body is able

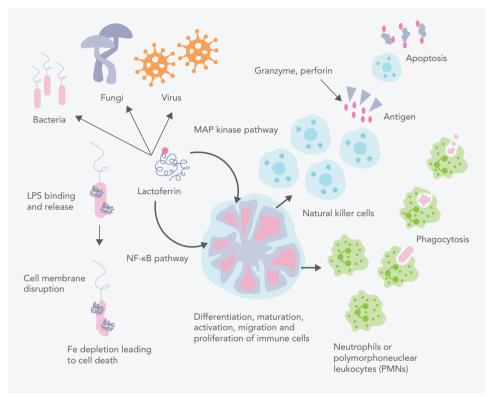
LACTOFERRIN AND THE IMMUNE SYSTEM

to synthesize glutamine itself, but glutamine is also needed in the diet, especially in high-activity individuals, chronically stressed, and those with many different medical conditions. To Glutamine is used by various immune system cells and is required to support optimal lymphocyte proliferation and production of cytokines by lymphocytes and macrophages.

- The health effects of glutamine in the body have been extensively studied. The main beneficial effects include, in particular, improving the balance and the condition of the intestine with the addition of glutamine. Glutamine, among other things, has been found to help people with food hypersensitivity by reducing the resulting inflammation of the gut lining.⁷⁷
- Glutamine can help repair leaky gut and hence improve also the immune system function.⁷⁸
 Getting enough glutamine from the diet or by using a supplement helps protect intestinal epithelial cell tight junctions (preventing intestinal permeability).⁷⁹

ELDERBERRIES AND OTHER DARK BERRIES

Dark pigmented berries have polyphenols and antioxidants that strengthen the immune



Source: Kanwar, J. & al. (2015). Multifunctional Iron Bound Lactoferrin and Nanomedicinal Approaches to Enhance Its Bioactive Functions. *Molecules* 20: 9703-9731.



system by modulating the gut microbiota.⁸⁰ Based on a study done on 60 people, taking 15 ml of elderberry extract 48 hours after the onset of influenza virus A or B can relieve the symptoms on average four days earlier.⁸¹ Elderberries have also been shown to reduce symptoms of flu on other trials, but the evidence is weakened by small sample sizes.⁸²

CONSUME FRUITS AND VEGETABLES

Regular consumption of fruits and vegetables may be beneficial for the immune system function: higher intake of fruit and vegetables have been shown to lead to both a reduction in proinflammatory mediators and an enhanced immune cell profile. 83 For example, one study done in 2012 found that increased fruit and vegetable intake improved antibody response to a vaccine that protects against *Streptococcus* pneumonia in older people. 84

PROBIOTIC FOODS

Bacteria like *Lactobacilli* and *Bifidobacteria* have been shown to improve gut health and immunity.⁸⁵ You can get them from fermented foods such as sauerkraut, kimchi, kefir and fermented dairy.⁸⁶ Also, the lack of fermented foods in the diet has been shown to cause a fall in innate immune response.⁸⁷



 Humans have a built-in security system called SIgA (secretory immunoglobulin A), which is present in mucosal membranes that line, for example, the nose and upper respiratory tract as well as the gut.⁸⁸ SIgA can

- prevent cold and flu viruses from entering the system. Based on experimental studies, probiotics may provide antiviral effects with two mechanisms: directly in probiotic-virus interaction or via stimulation of the immune system.⁸⁹
- Older adults especially can benefit from a long-term use of an oral blend of probiotics including *Lactobacillus plantarum*, *Lactobacillus rhamnosus* and *Bifidobacterium lactis*, which enhance secretory immunity and increase IgA antibodies. ⁹⁰ In another study, a probiotic strain *Bacillus subtilis* was shown to stimulate IgA in the elderly to reduce the frequency of respiratory infections by 45 %. ⁹¹ *Lactobacillus plantarum* has been shown to enhance human mucosal and systemic immunity and also prevent NSAID-induced (such as ibuprofen) reduction in T regulatory cells (a harmful phenomenon). ⁹²

SULFUR-RICH FOODS

One way to increase glutathione levels is by eating sulfur-rich foods like eggs, beef and dark leafy greens. 93 Cruciferous vegetables, like broccoli and cauliflower, are also beneficial sources of sulfur. 94



BUTYRATE

Short-chain fatty acids like butyrate have anti-inflammatory properties. 95 They repair the gut lining in the colon. The microbiome creates butyrate from digesting fiber and vegetables, but you can also obtain it from animal fats and amino acids to a certain degree.

PELARGONIUM SIDOIDES

The African geranium plant (*Pelargonium* sidoides) contains tannins that can help bacteria from attaching to the cell lining of the throat and lungs. It can reduce coughing and treat acute bronchitis according to several studies. It has also been shown to reduce the duration and severity of colds, but the evidence is still preliminary.⁹⁶

OLIVE LEAF EXTRACT (OLE)

Olive leaf extract (not to be confused with olive oil), contains polyphenols, notably *oleuropein* and *hydroxytyrosol*, that have antiviral, antibacterial, anti-inflammatory and antioxidant properties that may reduce upper respiratory infection rates. Based on a randomized controlled trial published in 2019, OLE decreases the duration of upper respiratory infection in high school athletes.

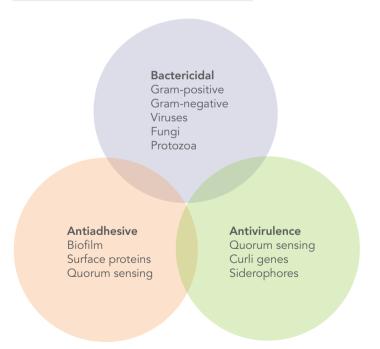
ALLIUMS AND GARLIC

- Allium vegetables like onions, leeks and shallots increase glutathione levels. 99 Garlic is a natural antibiotic and antimicrobial agent that kills viruses directly and strengthens immunity based on multiple studies. 100 101 102 Crush garlic and use it cold to activate its benefits. Alternatively, use 9 000 mg of high-allicin garlic supplement daily. Heating garlic destroys beneficial compounds in question. Aged garlic is also effective and has slightly different immunomodulatory effects. 103
- Black garlic is a functional food produced from fresh garlic via fermentation. Black garlic contains vast amounts of antioxidant compounds such as polyphenols, flavonoids, tetrahydro- β -carboline derivatives and organosulfur compounds, including S-allyl-cysteine and S-allyl-mercaptocysteine, as compared with fresh garlic. Fermentation has been shown to enhance the bioactivity of black garlic. A growing body of evidence demonstrates therapeutic effects of black garlic including antioxidant and immuno-modulatory effects: 104 black garlic extract supplement impedes inflammatory serum TNF α , interleukin-6 (IL6), and interleukin-1 β (IL1 β) production and prevents mice from LPS-induced death 105

OREGANO AND OTHER HERBS & SPICES

Oregano, and particularly oregano essential oil, is an effective antifungal and antibacterial substance. 106 Other herbs with similar properties include thyme, rosemary, clove, lemon balm and cat's claw. 107 Spices like cayenne pepper, chili pepper (containing capcaisin) and black pepper can also kill pathogens directly. 108 109

ANTIMICROBIAL EFFECTS OF HONEY



Source: Maddocks, S. & Jenkins, R. (2013). Honey: a sweet solution to the growing problem of antimicrobial resistance? *Future Microbiology* 8 (11): 1419–1429. Review.

TEAS

Green tea, black tea, and herbal teas have medicinal properties, such as polyphenols, that boost antioxidant defense systems and fight infections.¹¹⁰ ¹¹¹ ¹¹²

RAW HONEY AND BEE POLLEN

- Honey has antimicrobial peptides (including bee defensin-1, defensin-2, hemenopectin and apidaecin) and medicinal properties (such as flavonoids, polyphenols, vitamins and minerals) that strengthen the immune system. ¹¹³ It can also inhibit the growth of pathogens such as *E. coli* and *Salmonella*. ¹¹⁴
- Using raw honey as a sweetener is a great alternative to raw sugar and syrups. Bee pollen is also a powerful modulator of immune system function.¹¹⁵ Honey is an effective treatment for cough caused by an upper respiratory tract infection.¹¹⁶
- Be wary of giving honey to infants, as it can cause botulism¹¹⁷

ORGAN MEATS

Liver, kidney, and heart are nutrient-dense foods packed with essential nutrients your body needs. You should eat organ meats at least once a week to gain these benefits.

TOP ADAPTOGENS AND MEDICINAL MUSHROOMS THAT SUPPORT THE IMMUNE SYSTEM

Adaptogens (herbs and other substances that have been shown to help the body to adapt to stress) can also be helpful. Medicinal mushrooms, in general, are stimulating the production of macrophages that eat identified pathogens.¹¹⁸ ¹¹⁹

CHAGA MUSHROOM (INONOTUS OBLIQUUS)

- Chaga mushroom has the highest ORAC value (measure of antioxidant capacity) of any other food. It lowers cholesterol, triglycerides, inflammation and oxidative stress. 120 Polysaccharides from the chaga mushroom's fruiting body (PFIO) have been shown to effectively promote macrophage activation through the MAPK and NF-KB signaling pathways, which regulate the immune system function. 121
- Use as a water extract or an alcohol extract; combining both is the best option

REISHI MUSHROOM (GANODERMA LUCIDUM)

Reishi contains a huge variety of bioactive polysaccharides, beta-glucans and over 120 different triterpenoid compounds.¹²² It increases overall well-being, raises HDL-cholesterol, activates the immune system (CD3 and CD4 lymphocytes, NK cells), decreases TNF-alpha and reduces fatigue. 123 124

SHIITAKE MUSHROOM (LENTINULA EDODES)

Regular shiitake mushroom consumption has been shown to improve immunity (improved cell proliferation and activation and increased sIgA production) in a randomized dietary intervention in young adults.¹²⁵



TURKEY TAIL (CORIOLUS/TRAMETES VERSICOLOR)

Turkey tail has been shown to fight against leukemia cells *in vitro*¹²⁶ and improve the immune system of people getting chemotherapy. ¹²⁷ It contains 35 different phenolic compounds and flavonoid antioxidants *quercetin* and *baicalein*, which are strong antioxidants. ¹²⁸ Turkey tail also contains other substances, such as *Polysaccharide Krestin* (PSK) and *Polysaccharide Peptide* (PSP), which activate macrophages and modulate immune response. ¹²⁹ ¹³⁰ Turkey tail extract has been found to inhibit the growth of *Staphylococcus aureus* and *Salmonella enterica* in vitro (a test tube study). ¹³¹

ASHWAGANDHA

Based on animal studies, an adaptogenic herb ashwagandha has been shown to possess immunomodulatory effects (upregulating Th1 and macrophages). 132 133 In human studies, aswhagandha has been shown to lower stress and hence balance the function of the immune system. 134 135 In a very small human study (n=5), ashwagandha was shown to upregulate the expression of CD4 and CD3+ T-cells after 96 hours of consumption. 136

GINSENG

American and Asian ginsengs regulate immune cells such as macrophages, T-cells and natural killer cells. Ginseng also has antimicrobial properties.¹³⁷

GINGER

Ginger helps to lower inflammation, treat infectious agents, and protect against environmental stressors such as smoke and chemicals. 138



TURMERIC

Curcumin, the active compound of turmeric, has been shown to embody anti-inflammatory properties that can help in treating chronic pain and infections.¹³⁹ It also helps to boost glutathione levels in the body. Curcumin and turmeric also have antibacterial, antiviral and antifungal properties in humans.¹⁴⁰

ASTRAGALUS

Astragalus has been used in Chinese medicine for thousands of years. Research shows it protects against gastro-intestinal inflammation and has immune system boosting properties. It in one study, an herbal tincture of astragalus, echinacea and glycyrrhiza stimulated immune cells within 24 hours of ingestion and remained active for at least 7 days. It is tube studies have shown that Astragalus membranaceus extract activates immune response in macrophages (a pathogen destroying cell in the immune system). It is a very potent herb for activating autophagy pathways and can have therapeutic potential in autophagy dysregulation-associated diseases because of their biological positive effects. It

FOODS AND SUBSTANCES THAT WEAKEN THE IMMUNE SYSTEM

Not everything is good for you. Consider avoiding the following during times of infectious diseases:

X CIGARETTE SMOKING

- Smoking undermines the immune system and increases risk of respiratory infections and pneumonia and the risk of death from these diseases. Smokers also incur a 2- to 4-fold increased risk of invasive pneumococcal disease. Influenza risk is severalfold higher and is much more severe in smokers than nonsmokers. 146
- Recently, studies found that 2019-nCov and SARS-nCov share the same receptor, ACE2. There is a significantly higher ACE2 gene expression in people who smoke cigarettes than in those who do not smoke. This indicates that smokers may be more susceptible to 2019-nCov.¹⁴⁷
- When it comes to cigarette smoking, China is the "leading" country in the world: total prevalence was 27.7 % (51.2 % among men and 2.7 % among women). Lung cancer is the most commonly diagnosed cancer and the leading cause of cancer mortality in China.¹⁴⁸

X EXCESSIVE ALCOHOL INTAKE

Excessive consumption of alcohol impairs the immune system and increases the vulnerability to lung infections. ¹⁴⁹ In folk

medicine, there has been a practice of prescribing small doses of strong spirits like vodka and herbal tinctures to kill pathogens locally. It may also be beneficial in small therapeutic doses causing a so-called hormetic response in the body.¹⁵⁰

X INFLAMMATORY OILS AND RANCID FATS

Canola oil, margarine, sunflower oil, and seed oils in general are highly inflammatory and damage cell membranes when rancid. ¹⁵¹ Most cooking oils in restaurants and fast food places use vegetable oils that oxidize easily. Even healthy fats like olive oil or roasted nuts can become rancid. ¹⁵² You should use minimal heat when processing fats or meats to avoid the production of trans-fats, oxidized fats, and various carcinogenic compounds such as AGEs (advanced glycation end-products). ¹⁵³

X GLUTEN AND GRAINS

Even if you're not gluten intolerant, excessive consumption of grains can damage the gut lining and cause chronic inflammation. Feelined carbs like pastries and white bread are worse than traditional *sourdough* bread because the latter has bacteria that essentially pre-digest the gluten and increase the nutritional content. State Chronic avoidance of gluten isn't a smart idea because your body may lose its ability to deal with it. Reducing the consumption of grains drastically will improve gut health and lower inflammation, especially if you are sensitive to gluten and grains in general.

X HIGH SUGAR CONSUMPTION

Excess glucose reduces the ability of neutrophils (a type of white blood cells) to ingest and kill bacteria. ¹⁵⁸ In a 1973 study, subjects consuming 100 grams of carbs from different sources after an overnight fast reduced the effectiveness of neutrophils by about 40 % for 5 hours. ¹⁵⁹ This applied to sucrose, fructose, and honey as well as glucose. The least impactful was starch. Excessive amounts of carbohydrates can also promote low-level inflammation, increase risk for type 2 diabetes and make one more prone to infections. ¹⁶⁰ ¹⁶¹ ¹⁶²

X POULTRY

Chicken, turkey, and poultry, in general, have quite an unfavorable fatty acid profile. They are predominantly high in omega-6 fats, especially if the animals have been fed corn or grains. If poultry is the only source of omega-6, then it is not an issue, but if the diet is already high in omega-6, then it can make things worse. Too-high omega-6 to omega-3 ratio has been linked to increased inflammation. Factory-farmed birds are also more prone to infections and viruses due to living in confinement.

X PROCESSED MEAT

Bacon, sausages, dumplings, canned meat and other processed meats fairly often have sugar, grains, and preservatives added to them, which can be pro-inflammatory.

Nitrites present in processed meats can cause harmful compounds such as nitrosamines to form in the gut in absence of vitamin C.¹⁶⁵ ¹⁶⁶

X TOXIC SEAFOOD

Most seafood is high in mercury and other pollutants. Environmental toxins such as dioxins and PCBs (polychlorinated biphenyls) are concentrated in fish fat. Toxins become concentrated in long-lived and large predatory fish. Therefore, avoid large fish like tuna, shark, pike and halibut because they accumulate more heavy metals due to their size and eating habits. Smaller fish like trout, salmon, pollock, krill and oysters are lower in heavy metals. ¹⁶⁷ Farmed fish can be fed antibiotics as well as grains and other inflammatory foods that produce an unfavorable fatty-acid profile. ¹⁶⁸

X HEAVY METALS SUCH AS CADMIUM

Environmental pollution in the form of cadmium (Cd) has been shown to disrupt mitochondrial function and potentiate pulmonary inflammation in animal studies. Cadmium elevates inflammatory IL-4 levels and alters metabolites associated with fatty acid metabolism, leading to increased pulmonary inflammation during a viral infection.¹⁶⁹

COMMON SUPPLEMENTS AND DRUGS THAT SHOW NO PROMISE IN INFECTION PREVENTION

Over-the-counter availability of supplements and drugs for treating flu symptoms are common but most of them are actually ineffective:

* MULTIVITAMINS

In elderly subjects, multivitamin supplementation of B-vitamins, vitamin E, folate, and vitamin C has not been shown to have any meaningful protection against common infections. ¹⁷⁰ ¹⁷¹ However, it may be useful if you have deficiencies or an underlying medical condition such as type 2 diabetes. ¹⁷²

* VITAMIN E

Vitamin E is a common antioxidant and fat-soluble vitamin that improves cellular functioning by preventing the oxidation of cell wall protein structures. ¹⁷³ It is very difficult to be vitamin E-deficient if you are eating some healthy fats and vegetables. Based on an observational study on 72 000 participants, dietary vitamin E was associated with reduced risk of lung cancer, but vitamin E supplementation increased the risk. ¹⁷⁴

* ECHINACEA

Echinacea has immunostimulating properties, especially in treating upper respiratory infections.¹⁷⁵ Yet, more recent systematic reviews have found several trials of poor quality with the health benefits lacking greatly in statistical relevance.¹⁷⁶

* FISH OIL

Several animal studies demonstrate that although fish oil is anti-inflammatory in its nature, it can impair the production of immunoglobulin A¹⁷⁷ and delay recovery from influenza.¹⁷⁸ However, findings in mouse models may not be directly translated into humans since both organisms have differences at the immunological and metabolic levels. Based on a comprehensive scientific review done in 2019, omega-3 fatty acids ALA, DHA, and EPA exert an inhibitory effect on the activation of immune cells from both the innate and the adaptive systems. Still, some specific immune functions are promoted by dietary omega-3 fatty acids in specific immune cell types (for example, phagocytosis by macrophages and neutrophils or T-regulatory cell differentiation), suggesting that omega-3 fatty acids do

not act as immune suppressors.¹⁷⁹ In conclusion, the jury is still out on the use of fish oil in infection prevention.

*** COUGHING MEDICATIONS**

Coughing is a protective mechanism that clears airways of mucus and pathogens. None of the common overthe-counter drugs such as codeine, ¹⁸⁰ dextromethorphan (DXM), or antihistamines ¹⁸¹ are effective against the flu or coughing. ¹⁸²

* INHALING MENTHOL

Menthol may feel refreshing, but it will not help on nasal patency or cough prevention.¹⁸³

* PARACETAMOL

The use of painkillers for flu is common, but they are not effective in shortening the flu. Acetaminophen, or paracetamol, has actually been shown to increase the duration of colds, as it reduces the natural antibody response. ¹⁸⁴ In the cases of pneumonia, NSAIDs are actually harmful to the patient and impair neutrophil intrinsic functions, their recruitment to the inflammatory site, and the resolution of inflammatory processes after acute pulmonary bacterial challenge. This means slower recovery from the disease itself. ¹⁸⁵ Even more, a 2014 study found that fever suppression (with NSAIDs or other pain killers / antipyretics) increases the expected number of influenza cases and deaths in the US. ¹⁸⁶

STRATEGIES FOR STRENGTHENING THE IMMUNE SYSTEM

In addition to nutritional interventions, you can increase resilience against pathogens with healthy regular lifestyle interventions:

✓ REGULAR EXERCISE

Flushes the lymph system and increases blood circulation. It also stimulates the body's defense mechanisms and strengthens immunity by activating Nrf2.¹⁸⁷ Regular exercise has been shown to reduce upper respiratory infection prevalence.¹⁸⁸ Light and moderate exercise during sickness can even be beneficial in fighting the disease.¹⁸⁹ However, overtraining will actually make you more vulnerable to getting sick.¹⁹⁰ If you have a fever and you feel really sick, do not exercise.

✓ REGULAR SAUNA

• Sweating flushes the body from toxins and infections by improving lymphatic drainage and blood circulation. Both the traditional and infrared sauna kill pathogens due to heat. Regular sauna bathing has also been shown to strengthen the immune system. 191 Going to sauna over 2 times per week has been shown to reduce the

- risk of acute and chronic respiratory conditions, at least in middle-aged men. These include infections like pneumonia. 192
- Based on a study done on mice, short-term heat shock provides beneficial anti-HPAIV H5N1 ("the bird flu") properties, which offers an alternative strategy for non-drug prevention for influenza infection.¹⁹³

✓ MILD COLD EXPOSURE

Moderate exposure to cold doesn't increase the susceptibility to infections but instead increases resilience against them. 194 195 Just make sure the exposure time to cold or wind does not last too long. If you don't feel uncomfortable or frail from the cold then it can actually be useful. Preferably protect your neck, lungs, and stomach.

✓ INTERMITTENT FASTING

Regular intermittent fasting is an effective strategy to build resiliency against pathogens. Time-restricted eating can upregulate glutathione and autophagy to protect against sickness. ¹⁹⁶ The metabolism related to fasting also protects against bacterial inflammation but not viruses. ¹⁹⁷ It can be useful for prevention, but it is not effective if you are already infected with a virus.

✓ NUTRITIONAL KETOSIS

The ketogenic diet activates the Nrf2 pathway that lowers inflammation and oxidative stress. 198 Ketones also have signaling properties that inhibit HDACs (*histone deacety-lases*; a class of enzymes) associated with aging. 199 Being exposed to stress, jet lag, infections, and pollution is safer in a state of ketosis, whether that be with fasting or eating a ketogenic diet because the body is in a heightened state of self-defense. 200 Based on a mouse study from 2019, mice fed with a ketogenic diet were better able to combat the influenza virus than mice fed food high in carbohydrates. One of the physiological mechanisms was an increased expansion of $\gamma\delta$ T-cells in the lungs. 201

✓ REGULAR SUNLIGHT

The most bioavailable source of vitamin D is the sun.²⁰² You should get daily sunlight exposure as often as you can, but avoid getting burnt. The best time for sunlight is in the morning to help in balancing the circadian rhythm, which also has an effect on the function of the immune system.²⁰³ The immune system actually has its own circadian clocks, and when disturbed, the immune system also is disrupted.²⁰⁴

✓ REDUCE ELEVATED CORTISOL

If you are stressed, take time off to recover. Chronic stress (physiological and psychological) is one of the major contributors to an unbalanced immune system and predisposition to diseases.²⁰⁵ ²⁰⁶ Elevated cortisol levels have been noticed in patients with viral infections.²⁰⁷

✓ ADEQUATE SLEEP

- *Melatonin*, the sleep hormone, is also a powerful antioxidant that modulates autophagy and deep cell repair during sleep.^{208 209} The body repairs itself primarily in deep sleep, and sufficient sleep is extremely important for healthy functioning of the immune system. Melatonin acts also on both the innate and specific responses of the immune system via combined mechanisms that mainly involve the modulation of cytokines and the production of oxidative stress.²¹⁰ In addition, infection-fighting antibodies and cells are reduced during periods when you don't get enough sleep.²¹¹
- Supplementing with melatonin at bedtime may be useful in the early stages of infection to facilitate proper immune system response by increasing T-helper cell production, particularly of CD4+ cells. Production of IL-2, IL-6, and IL-12 are also stimulated by melatonin.²¹²

ENVIRONMENTAL PREVENTION AND TECHNOLOGICAL INTERVENTIONS

During virus episodes and pandemics, it is smarter to eat animal foods like meat and fish that have been frozen or bought locally. That way, you will be getting meat that was produced before the pandemic. Frozen temperatures can also kill certain pathogens directly.²¹³

Influenza viruses can survive up to 24 hours on hard surfaces and longer in more protected and moist environments. There are differences between bacteria and viruses. For example, *Salmonella* and *Campylobacter* can survive for 1-4 hours and norovirus for weeks on cold, hard surfaces. It is also notable that flu viruses survive only 5–15 minutes on hands or tissues.²¹⁴

Avoid open meat markets and fresh produce from infected regions. Wash all vegetables thoroughly. Consume cooked food unless you are going after specific nutrients.

Avoid eating in restaurants where hygiene may not be optimal and where potentially infected people are handling food and eating. Opt for cooking your own food whenever possible. Wash your hands before and after touching food.

Avoid touching your face or wiping your nose before washing your hands.

Use contactless payment cards instead of paper money and coins since they are likely vectors of dangerous transmissible diseases such as influenza viruses, Salmonella, norovirus, E. coli, S. aureus, rhinovirus, rotavirus and hepatitis A virus.²¹⁵

Wash your hands immediately when you enter your home or office; that also includes your mobile phone. Wipe the screen with an antiseptic towel.²¹⁶ Wash your towels regularly and consider having personal towels for family members.

Studies have shown that soap and water are best for washing hands.²¹⁷ ²¹⁸ Use disinfectants only when it is the only option; still, they are effective on preventing the transmission of multiple typical viruses, such as the rhinovirus. Disinfecting hands has been shown to reduce the secondary illness rate of rhinovirus infections.²¹⁹

The analysis of 22 studies reveals that human coronaviruses such as SARS, MERS, or HCoV can persist on surfaces like metal, glass, or plastic for up to 9 days but can be

efficiently inactivated by surface disinfection procedures with 62–71% ethanol, 0.5% hydrogen peroxide, or 0.1% sodium hypochlorite within one minute.²²⁰

A study from 2016, published in *BMC Infectious Diseases*, demonstrated a new formulation for a hand disinfectant: low alcohol content and added citric acid and urea. The researchers stated that this disinfectant is capable of inactivating all enveloped and non-enveloped viruses as indicated in current guidelines and thereby contributing as a valuable addition to the hand disinfection selection.²²¹

AIR TRAVEL DURING A PANDEMIC

- Wash your hands immediately after going through security—the trays are notorious for harboring more pathogens than toilet seats.²²² Also, remove all rings and watches before washing your hands. Rings, in particular, are well known to be collectors of microbes.²²³
- Do not dry your hands in jet air or warm air dryers
 because they will increase bacterial and viral aerosolization when drying hands. Based on a study published in
 2014, air bacterial counts in close proximity to hand
 drying were 4.5-fold higher for the jet air dryer compared
 with the warm air dryer and 27-fold higher compared

- with use of paper towels. The best way to dry your hands is to use paper towels.²²⁴
- Do not immediately queue to the plane. You can wait at a distance and observe the perfect moment for boarding. A study conducted in 2018 collected air samples from crowded areas at one airport—17% of samples tested positive for known respiratory pathogens.²²⁵
- Concern about the air cabin quality is largely unjustified. The highest risk for airborne infections happens actually while moving in and out of the aircraft. Cabin air ventilation was developed during the time when people smoked on airplanes, and most cabin air is effectively localized and removed with the exhaust or return air. Most of the circulated air goes through HEPA filters several times per minute. The risk of exposure to infectious persons is highest for the passengers seated closest to an infected person and for the cabin crew who work in the same section. If you notice someone sneezing next to you, consider changing your seating or using a face mask to protect yourself.²²⁶
- Consider upgrading your passenger class: business and first class have lower concentrations of airborne microorganisms.

- Go to the toilet before boarding the plane if you need to. Always use a paper towel or disinfectant wipe to touch doorknobs and locks. Do not use the toilet on the plane, if possible: on average, 38 % of flight passengers visit the toilet once, 9 % used it twice and 3 % used it more than two times.²²⁷
- Sit at a window, away from toilets, and at the very back or front of the plane. The aisle seats are more likely to be touched by more people and thus likely to get contamination from infected passengers and flight attendants.
- Turn on the ventilation above you and point the airway towards you. It is usually filtered air that goes through HEPA filters and other air filtration mechanisms. It creates an air bubble that protects you from potential droplets surrounding you.
- Ventilation in aircrafts is exceptionally effective, with less than 3 % risk of getting contaminated with other passengers. Face masks are useful if you have an infected person next to you.²²⁸
- Skip the food service and do not eat any snacks with bare hands. The filthiest part of your seat is the food tray, the pocket in front of you with brochures, and the seat belt buckle. Disinfect the seat belt buckle, armrests,

- remote control, touch screen, tray table, and overhead air vent buttons with a disinfectant wipe before you touch them.
- Low humidity on airplanes can increase risk for infections. Increase humidity with a specially designed respiratory device or mask. Use a moisturizing nasal spray to help combat low humidity.²²⁹
- Avoid unnecessary travel

SUGGESTIONS FOR A TRAVEL KIT

This kit includes everything you may want to consider to maintain maximum hygiene throughout your travels. Also useful on trains, ships and buses. You can view the kit in the **bonus materials page**.





TECHNOLOGICAL TOOLS FOR REDUCING PATHOGEN EXPOSURE

Here are technological remedies for reducing pathogen exposure by eliminating for example viruses at home and at the office.

LIGHT TECHNOLOGIES

Photobiomodulation is the utilization of non-ionizing photonic energy to trigger photochemical changes within cellular structures that are receptive to *photons*, particularly in mitochondria. At the cellular level, visible red and near-infrared light energies are absorbed by mitochondria, which perform the function of producing cellular energy (ATP) via cytochrome C oxidase. Photobiomodulation has been used in many kinds of situations and health problems to promote healing of the target tissue(s).²³⁰

Light technology can also be used to improve immunity and kill off pathogenic microbes. Currently, two light-mediated bactericidal techniques are widely studied. First, *photo-dynamic therapy* has been shown to have great potential against numerous pathogens: use of specific wavelength light to stimulate an exogenously supplied photosensitizer

elicits the formation of toxic levels of reactive oxygen intermediates. The concept of photodynamic therapy is not new; it was discovered over 100 years ago due to its ability to kill various microorganisms when the appropriate dye and light were combined in the presence of oxygen.²³¹ In the second method, light directly interacts with endogenous photosensitizers of the target microbe.²³²

Therapeutic potential of blue light (400–450 nm):

- The bactericidal effect of blue light has been shown in many pathogenic species
- Animal models have demonstrated blue light killing of infected cells a few hours after inoculation
- Little research has been translated into human clinical trials to date
- This technology has also been trialed in a hospital setting, producing modest reductions in bacterial counts on surfaces
- Blue light has been shown to kill biofilm in vitro

Therapeutic potential of red light (630–670 nm) and near-infrared light (780–940 nm):

 Red light has been shown to reduce cell numbers in some pathogens. This is possibly due to porphyrins,

- which absorb most strongly in the blue light region but also absorb other visible wavelengths.²³³
- Based on a murine leukemia model, the infectivity of virus particles can be reduced by exposure to visible light, such as red light²³⁴
- Irradiation with red and infrared light at doses ranging from 1 to 120 J/cm2 has a significant effect on destroying Gram-positive (S. aureus) and Gram-negative (P. aeruginosa and E. coli) bacteria²³⁵
- Enterococcus faecalis, a bacterial species that is resistant to blue light, is sensitive to near-infrared light (NIR) in vitro²³⁶
- NIR light (and blue light) has been shown to reduce viral load and cell death in ZIKV-infected (Zika infection) glioblastoma cell line²³⁷
- Photobiomodulation (PBM) has been shown to help modulate chronic stress; this means that with the use of light therapy, the whole system can achieve balance and homeostasis faster²³⁸
- Intranasal low-intensity laser therapy (ILILT) has a systemic effect on the body (red & infrared light). ILILT can enhance NAD+/NADH and SIRT1 activity until the system reaches function-specific homeostasis. ILIT may be used in the treatment and prevention of upper respiratory tract infections.²³⁹

- Intravenous laser blood irradiation (ILBI) with red light (630–670 nm) of blood has a direct effect on blood cells, resulting in higher anti-infection immunity and improved blood microcirculation.²⁴⁰ This therapy method has also been shown to lower the incidence and number of vascular diseases.²⁴¹
- In general, red light and infrared light therapy can be used to reduce inflammation in the body and in the lungs²⁴²

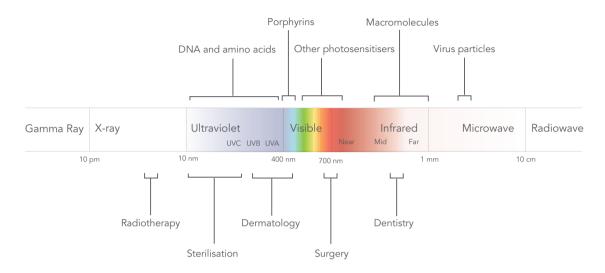
Ultraviolet light-emitting diodes (UV-LEDs) for disinfection:^{243 244}

- Ultraviolet (UV) disinfection is an effective technology for the inactivation of pathogens in water
- This technique is also used in hand dryers to provide simultaneous disinfection
- UV-LEDs improve microbial inactivation effectiveness by applying LED special features such as multiple wavelengths and pulsed illumination

Photodynamic inactivation (PDI) method:²⁴⁵

 Photodynamic inactivation can be used to directly destroy pathogenic microorganisms like bacteria, fungi, viruses, and protozoa

THE ELECTROMAGNETIC SPECTRUM AND CURRENT APPLICATIONS OF CERTAIN WAVEBANDS



Source: Gwynne, P. & Gallagher, M. (2018). Light as a Broad-Spectrum Antimicrobial. Frontiers in Microbiology 9: 119.

- In PDI the microorganisms are exposed to a photosensitizer, which gets irradiated with the spectral region corresponding to the photosensitizer absorption bands. Then it converts molecular oxygen into toxic reactive oxygen species (ROS), which destroys the pathogen.
- Enveloped viruses (e.g., influenza viruses, HIV, and HSV) can be inactivated by various photosensitizers

 A 2019 study showed that this method is effective in destroying a highly pathogenic Avian H5N8 influenza virus

AIR PURIFICATION AND DISINFECTION TECHNOLOGIES

Poor indoor air quality is a predisposing factor for respiratory infections, poisoning, chronic obstructive pulmonary disease, cardiovascular diseases, lung cancer and asthma.²⁴⁶

In hospitals, for example, indoor air quality plays a critical role: the environment requires special attention to ensure healthful indoor air quality (IAQ) to protect patients and healthcare workers against hospital-acquired infections and occupational diseases.²⁴⁷

According to studies, in office environments the indoor air can be 2–5 times (and sometimes up to 100 times) more polluted than fresh outdoor air.²⁴⁸

Actions for improving indoor air quality:

- Wipe off dust on a regular basis; use disinfectant wipes to reduce microbes and your exposure to them²⁴⁹
- Refrain from smoking indoors
- Have the indoor air quality analyzed
- Aim for these numbers for optimal air quality:
- Carbon dioxide content (CO2): < 625 ppm
- Humidity: 35-65 %
- Temperature: 19 °C (66 °F)
- VOC content: < 150 ppb
- Particle count: < 12.5 µg/m3
- Ventilate your home and office frequently (for example 5 minutes every hour)
- Purchase an air purifier and an ionizer that spreads ions into the air, trapping negatively charged particles

- Purchase an air humidifier
- Consider purchasing an UV-LED air and/or water purifier
- Use ozone treatments to remove unpleasant odors
- Consider purchasing a smart & active breathing green wall, such as Naava
 - Naturalizes indoor air
 - Reduces harmful chemicals
 - Optimizes humidity
- Purchase plants that purify indoor air. The following plants are recommended by NASA:²⁵⁰
 - Gerbera dairy
 - Bamboo palm
 - Peace lily
 - Warneckei
 - Marginata
 - Mother-in-law's tongue
 - Janet Craig
- Renovate your home to incorporate breathable and natural building materials
- "Medicinal smoke" provided by ethnopharmacological natural products has been shown to reduce airborne bacteria. Based on a 2007 review article, a 1-hour treatment of medicinal smoke emanated by burning wood and a mixture of odoriferous and medicinal herbs on aerial bacterial population caused over 94 %

reduction of bacterial counts by 60 minutes. The ability of the smoke to purify or disinfect the air and to make the environment cleaner was maintained up to 24 hours in the closed room.²⁵¹

 Daylight exposure has been shown to lower the abundance of viable bacteria. This means that the sunlight inactivates microbes under daylight conditions.
 Whenever there is sunlight available, it is recommended to open up the curtains to let the sunlight in.²⁵²

Also beneficial for improving air quality and supporting the immune system:

PATCHOULI OIL

An alcohol extract of *Pogostemon cablin*, or Korean mint (*huo xiang* in traditional Chinese medicine), has been shown to inhibit viral replication of various influenza viruses and reduced plaque formation by 75 % in vitro ("in a test tube").²⁵³ One mouse study has confirmed the anti-influenza effects in vivo ("in an organism"). Whether these effects carry over to humans is not known. Use it as an essential oil with antiviral and antibacterial properties on airborne pathogens for now.²⁵⁴

ESSENTIAL OILS

Eucalyptus, cinnamon, clove and rosemary oils have been shown to have antibacterial and antiviral properties on airborne pathogens.²⁵⁵

MYRRH

Myrrh is a resin or sap-like substance extracted from a number of small, thorny tree species of the genus *Commiphora*. It is used to treat hay fever and wounds. It possesses antibacterial and antimicrobial properties.²⁵⁶ Myrrh essential oil has been shown to fight infections when combined with frankincense.²⁵⁷

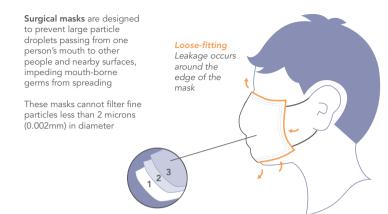
RECOMMENDED PRACTICES IN PUBLIC PLACES

When in public, consider the following cautionary measures:

- Wash hands before eating, after going to the toilet, coming to work and returning home
- Change towels frequently at home
- Don't touch your face, eyes, nose or mouth before washing your hands
- Clean your mobile devices and jewelry frequently
- Use contactless payment methods instead of paper money and coins
- Open public doors and press elevator buttons with gloves on or use your elbows
- Avoid touching handrails
- Don't eat or place food on public surfaces
- Stay away from large crowds in poorly ventilated areas
- Don't use the hand dryers in public toilets opt for paper, clean towels or hand sanitizer

If you have symptoms, consider the safety of others:

- Use a face mask and ensure a tight fit if you are sick
- \bullet Isolate yourself from others until you are well
- Cough into a handkerchief or your elbow never into your hands
- Dispose used handkerchiefs immediately
- Avoid touching public surfaces without gloves on

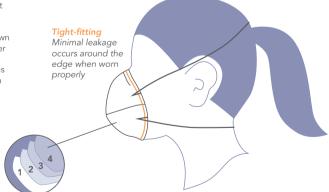


1. Outer hydrophobic layer Repels water, blood and bodily fluids 2. Middle layer Is designed to filter bacteria

3. Inner hydrophilic layer
Absorbs water, sweat and spit

N95 respirators filter out most airborne particles, protecting wearers from breathing in particles down to 0.3 microns in diameter

However, the coronavirus measures 0.12 microns in diameter



1. Non-woven layer Filters particles 0.5 micron in diameter 2. Activated carbon filter layer
Absorbs chemical pollution

3. Cotton layer Filters particles 0.3 micron in diameter

4. Second non-woven layer
Breathable and comfortable

OVERVIEW OF VIRAL INFECTIONS

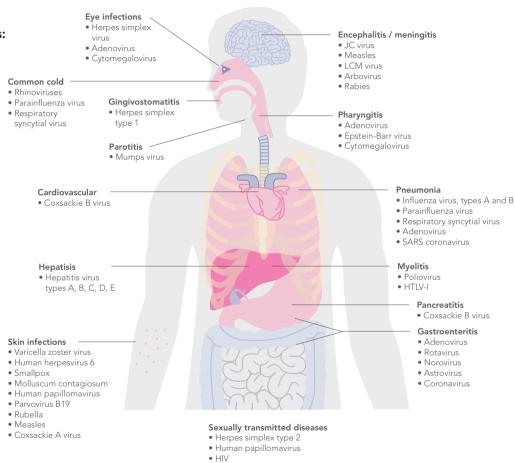
DETECTING AN INFECTION

Consider getting yourself checked by a medical doctor if you have some of the following symptoms:

- Fever, chills or malaise
- Red or runny eyes
- Runny nose or sneezing
- Difficulty breathing or swallowing
- Sore throat, cough or wheezing
- Changes in skin color
- Swollen tongue or lymph nodes
- Headache, photosensitivity or sensory distortions
- Stomach pain, cramps, diarrhea or vomiting
- Internal bleeding or bloody stool
- Skin rashes or bleeding
- Joint or muscle aches
- Sinus, ear or urinary tract infection
- Testicular pain

For example, influenza is characterized by sudden onset of fever, myalgia, headache, malaise, dry cough, sore throat, and nasal congestion.

Gastrointestinal symptoms, including nausea, vomiting and diarrhea, are also common. The incubation period of influenza (time from infection to development of symptoms) is 1 to 4 days.²⁵⁸



Source: Häggström, M. (2014). Medical gallery of Mikael Häggström 2014. WikiJournal of Medicine 1 (2).

LABORATORY TESTING AND SELF-QUANTIFICATION

For early detection, it is advised to pay attention to the following biomarkers that can be quantified at home with wearables and finger blood tests.

If you note any of the following, beware of the possibility of a more severe infection like pneumonia:²⁵⁹

- Elevated body temperature
- Elevated daily average resting heart rate by 20 beats
- Greatly reduced nightly heart rate variability (HRV)
 where average drops below 10 ms on a continuous
 basis (looks often like a flat line)²⁶⁰
- Respiratory rate continuously over 30/min
- C-reactive protein (CRP) over 20–30 mg/L

These tests should be performed in a rested state. Note that these values can be acutely influenced by alcohol, drugs, heavy exercise and sleep deprivation.

If you notice clear differences to your normal baseline (heart rate, temperature, HRV & respiratory rate), consider starting a regimen of preventive measures

including supplementation with zinc, vitamin D and other immunomodulatory agents listed in this guide.

Biohacker's Handbook on <u>Invincible Immunity</u> has an extended section on measuring the general condition of the immune system through laboratory testing.

You can take these basic laboratory tests to evaluate the possibility of an infection:²⁶¹

- C-reactive protein (CRP)
- Complete blood count
- White blood cell count (WBC count), in particular consider also taking WBC differential
- Polymorphonuclear leukocyte counts (to distinguish between bacterial and viral infections)
- Procalcitonin (PCT)
- Interleukin-6 (IL-6)



RECIPES FOR INCREASING YOUR RESILIENCY

FERMENTED FLU FIGHTER

Fermentation is a process where bacteria or yeast break down carbohydrates in the foods that convert them into alcohol and acid. Fermentation has been used as a preservation method in many cultures for centuries. Lately, fermentation has been gaining more attention, and its potential health benefits have been studied comprehensively. Fermented foods are known to improve digestive tract health and overall immunity. Fermented foods also provide other health benefits such as antioxidant, antimicrobial, anti-fungal, anti-inflammatory, anti-diabetic and anti-atherosclerotic activity. Fermented foods also anti-atherosclerotic activity.

If you want to do the fermentation by yourself, it is recommended to use edible wild herbs and plants whenever possible. Of course, using kale, carrot and other more traditional plants is also beneficial. You can make a mixture of these wild plants: nettle, dandelion, ground elder, sea beet, sea aster, wild cabbage, garlic mustard, common hogweed and cow parsley. After picking up the wild plants, wash them and dry them. Shred the plants you'd like to use. Place the plants in a large open bowl and add in Himalayan pink salt or natural sea salt. Follow traditional fermentation methods thereon.

Another option is to upgrade already fermented foods into a very potent immune system booster and flu fighter.



RECIPE

PIMP YOUR FERMENTED FOODS

Buy an organic sauerkraut or kimchi box from the food store, then do the following to make a delicious meal:

- 100–150 grams of fermented foods on a plate
- Add in some lemon juice, ginger juice and salt to taste
- Add a pinch of black pepper, cayenne pepper & turmeric
- 50 grams of lingonberries
- 4 large brazil nuts (for selenium)
- 2–4 organic pasture-raised boiled eggs (running yolk)
- Pour into a glass 200 ml of seabuckthorn juice and mix in 1 000 mg of lactoferrin (open up capsules and pour in)

Enjoy the meal with gratitude and take your time.

RECIPE

BRILLIANT BROTH BOMB

- 1 I (4 cups) bone broth
- 2 tbsp ground kelp
- 3 beetroots, chopped
- 5 black garlic cloves chopped
- 2 tbsp turmeric
- 1 tbsp of dried thyme, rosemary, clove & oregano (mixture)
- ½ tsp of cayenne pepper
- ½ tsp black pepper
- 2 tbsp apple cider vinegar
- ½ tsp unrefined sea salt
- Add in 10–20 g L-glutamine

If you want to make this soup even more nutritious and fulfilling, you can add in organ meats such as liver.

Prepare one liter (4 cups) of bone broth and add the rest of the ingredients (except for the garlic). Let the soup simmer for 90 minutes. Add garlic towards the end of the cooking time. Enjoy the slightly cooled soup in good company.

* From the bones of a grass-fed or wild animal; another option is to use fish bones and paring – if you are following a plant-based-diet use 100–200 g of mushrooms such as shiitake, maitake and portobello, instead of bones.



RECIPE

ANTIVIRAL SHIELDING TINCTURE

- 2 tbsp reishi powder
- 2 tbsp curcumin powder
- 1.5 tbsp chaga powder
- 1 tbsp Cat's claw powder
- 1 tsp astragalus powder
- 1 tsp black pepper
- 1/2 tsp cayenne pepper
- Black glass jar (500 ml) like Miron
- 350 ml high-quality vodka (like Russian Standard Platinum) or highquality gin (like Kyrö Napue Gin)

Put one-third of the vodka/gin to the glass jar. Mix in all the powders while slowly stirring. Pour the rest of the vodka/gin into the glass jar and keep stirring. Let the tincture "brew" for 4 weeks. Once ready, filter the liquid into another glass jar. Divide and pour the tincture into 50 ml black tincture bottles. Use anything between 3–12 droplets per day, especially when the flu season is on.



RECIPE

AUTOPHAGY ACTIVATOR

- 2 tbsp cardamom
- 2 tbsp curcumin
- 2 tbsp ginger
- 1 tbsp cinnamon
- 1 tbsp spirulina
- ½ tsp black pepper
- ½ tsp cayenne pepper
- ½ tsp rosemary
- ½ tsp cloves

The best way to activate autophagy is by fasting. Therefore, water is the best drink in terms of autophagy. However, some herbs have been shown to stimulate the pathways that are activated in autophagy, like AMPK.

Mix all the herbs and spices in a large Zip-lock bag or a Mason jar. Stir the blend together and store in a cupboard away from direct sunlight and moisture. Take 1 tsp daily when you are fasting, for example, in the morning. Mix with 3–4 dl hot water. Drink and enjoy slowly.

CONCLUSION

As humans we are part of the whole ecosystem of the planet earth. Based on the hygiene hypothesis and nowadays better known as the *old friend hypothesis*, our modern way of living has alienated us from the natural environment.²⁶⁴ This has created a discrepancy between our ecosystem and the immune system due to the lack of adequate exposure to pathogens since childhood. While allergies and chronic inflammatory conditions are in a dramatic rise, this inadequate exposure to the natural environment or so-called epidemic of absence has created a lot of debate in the scientific community.²⁶⁵ It seems that reduced bacterial, fungal and viral exposure due to generous usage of cleaning agents and other aspects of a modern lifestyle may not be healthy for us in the long run. However, in times of a serious epidemic it is not only wise but a virtue to pay more attention to personal and collective hygiene – ignorance is not bliss but informed preparedness is. Symptoms of a common cold like sneezing, sore throat, runny nose or mild fever are not something to be afraid of but to embrace them as part of the natural mechanism through which the body gets rid of pathogens and builds immunity.

The best way to protect yourself from new pathogens comes through balancing the basic elements of your life:

sound sleep, diverse whole-food diet, adequate exercise and movement, proper stress management and recovery, reduced alcohol and cigarette use, positive outlook on life and fixing possible nutritional deficiencies. In times of an epidemic, it is a great excuse to change your lifestyle. A well-functioning immune system is a reflection of the total state of health of the body. A healthy person is an ecosystem of different life-forms that live in balance with each other and the environment. This is called *the holobiont* which is essentially a collection of the host (human) and many other species living in and around it (colonies such as the microbiome, fungiome and virome), which together form a discrete well-functioning ecological unit.²⁶⁶

Best recommendations for supplements, nutrients and technological tools for protecting your immune system and attacking pathogens presented in this guide are found in the bonus materials page.

May you have a long healthspan in addition to lifespan.



biohack.to/fluguide

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