



Your guide to
immune health

A comprehensive resource for patients

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What is the immune system?

The immune system is the body's first line of defense against harmful invaders, such as viruses, bacteria, and other foreign bodies. The immune system consists of various organs, cells, and tissues, such as the skin, lymph nodes, tonsils, thymus, spleen, bone marrow, white blood cells, and microbiota.

Its pivotal role is to distinguish our tissue from foreign cells and to initiate an immune response when exposed to dangerous pathogens and subsequently defend against infection.

How does the immune system function?

The immune system relies on two subsystems: **the innate and adaptive immune systems.**

The **innate immune system** includes physical barriers, such as skin and mucous membranes, as well as cells that attack foreign invaders. If a pathogen is able to enter into the body, an inflammatory response is triggered and defense cells, such as macrophages and neutrophils granulocytes, attack the pathogen.

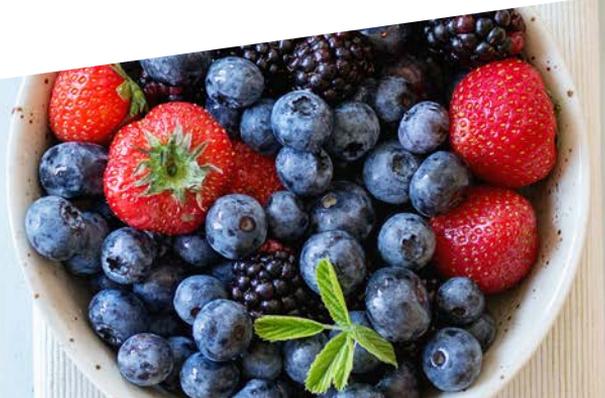
The **adaptive immune response** is the body's learned response to pathogens that it has previously encountered. The adaptive immune response kicks in if a pathogen is able to withstand the initial attack from the innate immune response and remains in the body for approximately four to seven days.

Two types of white blood cells, **B lymphocytes** and **T lymphocytes**, join the fight to protect the body. B lymphocytes fight bacteria and viruses by creating antibodies. T lymphocytes are produced in the bone marrow and mature in the thymus, where they transform into helper, regulatory, cytotoxic, or memory T cells.

Helper T cells identify foreign antigens, secrete cytokines (cell signaling molecules), and activate B cells and cytotoxic T cells, which are responsible for killing target cells.

Regulatory T cells control the immune system to help prevent autoimmune disease. Autoimmune conditions result from an overactive immune system that mistakes the body's own cells for foreign cells.

Lastly, **memory T cells** remain in the body to protect against previously encountered pathogens. If you've ever wondered why there are certain illnesses you can only contract once in your lifetime, such as chickenpox, memory T cells are responsible.



What factors can compromise the immune system?

Immune function can be negatively impacted by a number of lifestyle factors, many of which are modifiable. These factors include:

- Alcohol abuse
- Certain nutrient deficiencies (e.g., vitamins A, B, iron, and zinc)
- Environmental exposure
- Excessive, strenuous exercise
- Imbalance of gut microbial community
- Long-term stress
- Poor dietary habits (e.g., Standard American diet)
- Poor sleep habits
- Sedentary lifestyle
- Smoking and e-cigarettes

Chronic illnesses and other health conditions may increase your susceptibility for diminished immune function, including:

- Allergic asthma
- Autoimmune conditions (e.g., type 1 diabetes, lupus, and rheumatoid arthritis)
- Cardiovascular disease
- Certain cancers (e.g., lymphoma and leukemia)
- Immunodeficiency diseases (e.g., acquired immunodeficiency syndrome)
- Food allergies
- Organ/tissue transplant rejection
- Type 2 diabetes

Additionally, certain prescription medications can weaken the immune system, including:

- Antibiotics
- Antifungals
- Corticosteroids
- Cytotoxic drugs (used to treat cancer and autoimmune diseases)
- TNF inhibitors

Immune function & aging

As you age, your immune system naturally becomes less robust. Older individuals produce fewer B cells, which may result in an increased susceptibility to disease. While antibody production remains the same as we age, antibodies become less effective

at attaching to antigens and memory cells are slower to respond to antigens they've encountered before. This may explain why mortality rates due to influenza and pneumonia are higher in aging populations.





Chronic stress

Long-term, chronic stress has been shown to suppress immune function.



Physical inactivity or excessive exercise

Moderation is key when it comes to benefiting from the immunoprotective effects of exercise.



Poor diet

Diets high in processed foods, saturated fat, sugar, and excess sodium are linked to compromised immunity.



Nutrient deficiencies

Certain vitamin and mineral deficiencies have been associated with dysregulated immune function.



Substance use

Excessive alcohol intake can reduce immune function and increase your risk of certain infections.



Lack of sleep

Chronic sleep loss has been associated with systemic inflammation and an increased risk of infections.



Poor personal hygiene

Failing to practice proper personal hygiene can promote the transmission of certain pathogens.



Impaired microbiota

Your intestinal microbiota play an important role in maintaining homeostasis and regulating immune function.



Environmental toxins

Overexposure to toxins, such as parabens and heavy metals, can result in immune dysfunction.

9 factors affecting immune health

7 lifestyle tips to maintain a healthy immune system

Manage your stress levels

Short-term stress, also known as the fight-or-flight response, is an essential mechanism for protecting the body when encountering a threat. Chronic, long-term stress, however, can take a toll on your immune system and overall health. When stress levels are high for extended periods of time, the stress hormone cortisol is chronically elevated, which can suppress immune function and leave you vulnerable to illness.

Incorporate mindfulness & meditation

Mindfulness and meditation are common strategies used to combat stress. Mindfulness describes a state of being focused and present in the moment, while meditation is a set of techniques that are intended to provide mental clarity and a calm state of mind. Benefits include reduced anxiety levels, improved chronic pain, and better sleep. For more information, refer to the “Resources” section at the end of this guide.

Get adequate, good quality sleep

Chronic sleep deprivation is associated with immunodeficiency, systemic inflammation, and an increased risk of infections, including the common cold. Try to get between seven and nine hours of sleep per night.

Optimize your sleep by maintaining a regular sleep schedule, avoiding caffeine and other stimulants after lunchtime, and reducing screen time and noise levels in your bedroom. Blue light from your laptop, cellphone, or television can interfere with your body’s circadian rhythm (daily sleep-wake cycle). When possible, turn off or avoid all devices for at least two hours before bedtime. Refer to the “Resources” section for more information regarding sleep hygiene.





Stay hydrated

Stay well-hydrated by consuming two to three liters (60-100 fl oz) of filtered water and herbal tea throughout the day. Proper hydration is especially important if you're already ill, particularly if you're experiencing diarrhea and/or vomiting.

Beverages like coffee, caffeinated tea, soda, and alcohol all act as diuretics and make you excrete water more quickly. Diuretics may be especially problematic if you're highly active or are spending time outdoors. Be sure to moderate your consumption of these beverages and be sure to drink water to keep hydrated.

Did you know?

Signs of dehydration include dry mouth, dark-colored urine, dizziness, headache, and fatigue. If you notice any of these signs, drink up.

Establish a consistent exercise routine

Research has demonstrated the many health benefits of exercise, including improved blood sugar control, increased concentration, lowered risk of cancer, and improved cardiovascular health and immune function. Regular exercise increases circulation and encourages increased levels of T cells, which are responsible for fighting off viral infections. However, excessive strenuous exercise, such as competitive athletic training, may result in impaired immunity for up to 72 hours.

The **Physical Activity Guidelines for Americans** recommend that adults participate in 150 to 300 minutes of moderate-intensity exercise per week. Try to find activities you enjoy, whether that's cycling, running, hiking, yoga, or weight lifting. Set yourself for success by designating small, measurable goals. Commit to walking 30 minutes three times per week or going to a new fitness class at the gym. Once you've tackled your first goal, build upon it, or set a new, more challenging goal for yourself. See the "Resources" section for specific physical activity recommendations.

Practice proper personal hygiene

Frequent and thorough hand washing can help prevent the spread of harmful pathogens. Washing your hands for 20 seconds with soap and water is ideal, however, alcohol-based hand sanitizer can be used as a substitute if soap and water is not available.

Avoid touching your eyes, nose, and mouth to prevent germs from entering the body. If you're ill, do your best to distance yourself from others, cough into your elbow as opposed to your hand, and quickly dispose of used tissues to prevent the spread of illness to others. Regularly disinfect shared surfaces to further prevent the spread of illness.

Reduce exposure to cigarette smoke

When compared to nonsmokers, smokers are at higher risk for chronic illnesses, such as cancer and heart disease, inflammation, and a weakened immune system. Quitting smoking improves circulation and reduces inflammation, which contributes to a stronger immune system.

Use caution with e-cigarettes, too. While e-cigarettes don't contain tobacco, they do contain nicotine and other harmful chemicals. Positive effects of smoking cessation can appear within just a few days, so it's never too late to quit. Seek out the help of qualified health professionals when trying to reduce or quit your smoking habit.

Did you know?

Circulation and lung function can improve in as little as two weeks after quitting smoking.



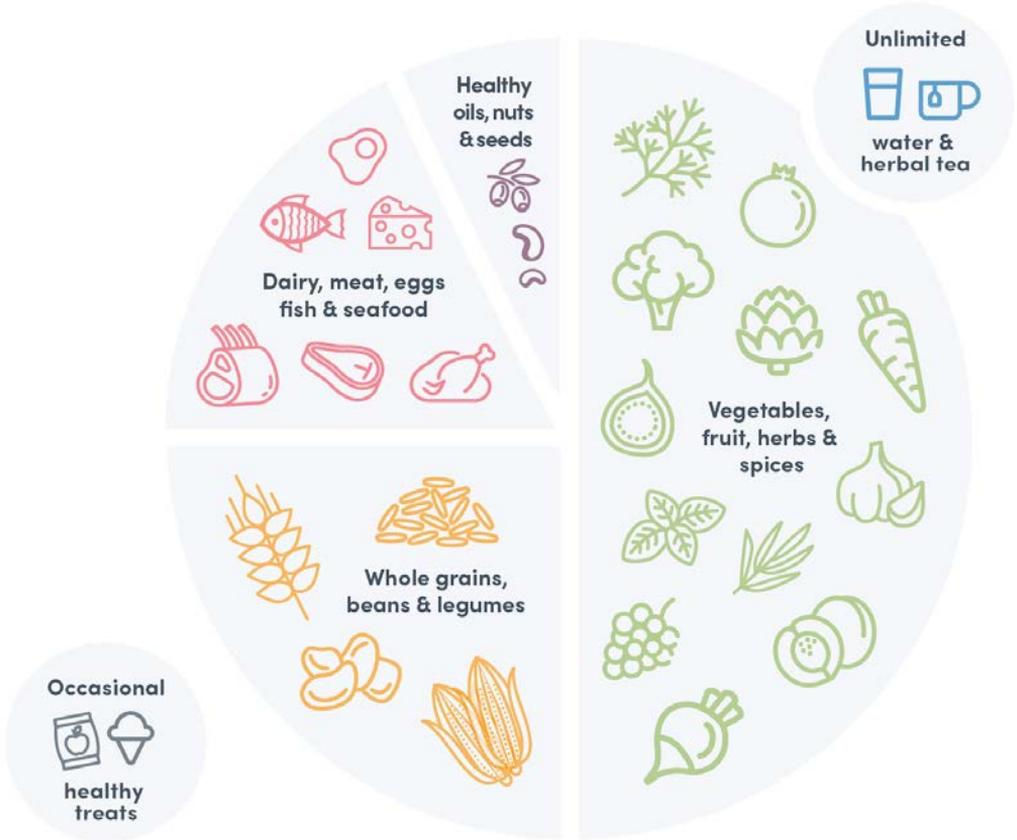


Foods that support the immune system

While eating certain foods can't reduce your exposure to viruses and other pathogens, making the right dietary choices can give your immune system a fighting chance against foreign invaders. Eating a wide variety of whole foods, particularly fruits

and vegetables, can support your immune system and overall health. Refer to the "Resources" section for a comprehensive healthy grocery guide to assist you in shopping for healthy foods.

Components of a healthy diet



✂ Print me out and stick me on the fridge!

Vegetables & fruit

Rich in vitamins, minerals, fiber, and phytonutrients, fruits and vegetables are necessary to maintain a robust immune system. When choosing produce, keep in mind that variety is key. Aim to eat varying colors of produce each day to consume a complete range of vitamins and minerals.

Current recommendations suggest consuming one to two cups of fruit and one to three cups of vegetables per day. To better visualize this, imagine filling half of your plate at each meal with fruits and vegetables.

When it comes to produce, fresh and frozen are your best options as they are the least processed, but low sodium/sugar-free

canned fruits and vegetables are fine in a pinch. If using canned fruits and vegetables, drain and rinse them when possible to further reduce their sugar and/or sodium content.

Choose certified organic produce when possible to reduce your exposure to herbicides and pesticides. Persistent exposure to herbicides and pesticides may increase your risk of developing certain autoimmune disorders and cancer. For further guidance, refer to the Environmental Working Group's (EWG) dirty dozen and clean fifteen guidelines found in the "Resources" section.





Beans & legumes

Legumes, which include beans, lentils, peas, and soybeans, are a common dietary staple for cultures around the world and for good reason. Beans and legumes are an excellent source of fiber, plant-based protein, and essential micronutrients, including B vitamins, vitamin K, manganese, and iron. The soluble fiber in beans and legumes is particularly beneficial for boosting immune function because it encourages growth of healthy bacteria in the gut. These healthy bacteria protect from intestinal infection and stimulate the immune response.

Certain beans also contain high levels of antioxidants that protect your cells from oxidative stress. Black beans and kidney beans are great examples. Dried beans are the least processed option available, however, low sodium canned beans provide similar nutritional value.

Be sure to drain and rinse canned beans thoroughly to remove the salty solution they're stored in. The Mediterranean diet, which many practitioners recommend for disease prevention, suggests consuming at least three servings of beans per week.

Did you know?

Anti-nutrients found in whole grains and legumes may affect the body's ability to absorb nutrients. Anti-nutrients can be reduced using certain preparation techniques, such as boiling, soaking, sprouting, and fermenting.

Whole grains

There are three main components of grains—the germ, the bran, and the endosperm. Whole grains differ from refined grains in that they contain all three elements. This is important because the germ and bran are rich in vitamins and minerals, such as B vitamins, vitamin E, zinc, and fiber, all of which contribute to immune health. When a grain is refined, the germ and bran are stripped away, taking their nutrients with them and leaving behind the endosperm.

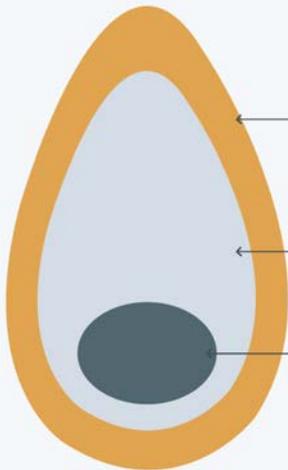
Furthermore, many whole grains contain a form of soluble fiber called beta-glucan, which may stimulate the immune system.

Examples of whole grains include whole wheat, brown rice, barley, farro, buckwheat, and oats. Current recommendations advise eating three to six servings of whole grains per day with a serving size equating to ½ cup cooked or one slice of bread.

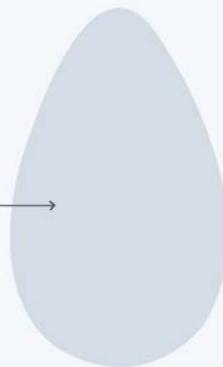


Whole grain vs. refined grain

Whole grain



Refined grain



Bran

Outer layer of whole grains which contains fiber, protein, B vitamins & iron

Endosperm

Starchy, energy-rich middle layer

Germ

Rich in fiber, magnesium, zinc & vitamin E



Lean animal proteins

Lean cuts of meat contain zinc, which helps ramp up the production of white blood cells and control inflammation in the body. Protein is involved in the production of immunoglobulins (antibodies), which support the immune response by assisting in identifying, binding, and destroying antigens.

Following the Mediterranean diet guidelines, consume three-ounce portions of white meat up to three times per week. Intake of red meat should be limited to one three-ounce serving per week. The diet also allows for moderate amounts of dairy and eggs; intake should be limited to two to four eggs per week and three servings per week of dairy.

Quick tip:

When purchasing animal products, look for organic, free-range, pasture-raised, wild-caught, and sustainable options.

Nuts & seeds

Nuts and seeds are rich in vitamin E, a potent antioxidant, which is essential for a healthy immune system. Vitamin E protects cells from oxidative damage and may resist the decline of T cell immune response commonly associated with aging. Their high fat, protein, and fiber levels also increase satiety, making them a great mid-day snack. Aim to consume 1.5 ounces, approximately a quarter cup serving, of nuts and seeds a few times per week.

Healthy fats & oils

When choosing fats, select foods containing heart healthy, unsaturated fats. Unsaturated fats are found in olive oil, avocado oil, nuts, and seeds. Fatty fish, such as salmon and mackerel, are also excellent healthy fat sources. They are rich in omega-3 fatty acids that may reduce inflammation in the body. Fat is also particularly important for absorption of the fat soluble vitamins, A, D, E, and K, all of which support immune function. Oils are energy-dense, so limit daily intake to 2 tablespoons per day.

Spices

Certain herbs and spices boast protective health benefits. Curcumin, the active ingredient in turmeric, has been shown to improve inflammation and the immune response. Garlic is rich in sulfur-containing compounds called allicin, which may improve the disease-fighting response of white blood cells. Ginger also possesses anti-inflammatory and antioxidant effects.

Mushrooms

Certain mushrooms, such as white button and wild mushrooms, have been shown to support immune health. Mushrooms are a source of vitamin B, C, D, and E, which can improve immune function. Bioactive polysaccharides in mushrooms have also been shown to enhance the innate and adaptive immune responses. Additionally, mushrooms may positively influence the gut microbiota, improving protection against pathogens.

Foods to limit/avoid

The Standard American diet, characterized by a high intake of foods high in fat, sugar, and sodium, is linked to poor health and compromised immune function. This dietary pattern contributes to increased inflammation, lower resilience to infection, and increased rates of cancer.

Do your best to limit or completely avoid the following foods and beverages:

- Alcoholic beverages
- Fast food
- Refined carbohydrates (e.g., white bread, pasta)
- Soda and other sugary beverages
- Ultra-processed foods (e.g., packaged snack foods, candy)



Immune support resources



Mindfulness tips

Mindfulness is a mental state defined as: the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment.

Developing mindfulness involves formal practices, such as sitting meditation, body scanning, and mindful movement, as well as informal mindfulness, where the practice is integrated into everyday activities such as commuting or doing dishes.

Start slowly

Some of the challenges individuals commonly report with mindfulness practice include a lack of motivation and insufficient time. If you're new to mindfulness, you can start with meditating for one to three minutes per day, gradually building up from there. It may be helpful to incorporate mindfulness practices consistently at the same time each day to establish a regular routine.

Be patient with yourself

Remind yourself that mindfulness practice shouldn't be focused on an outcome, but on the experience itself. According to John Kabat-Zinn, a pioneer in contemporary mindfulness research and practice, "from the outset of practice, we are reminded that mindfulness is not about getting anywhere else or fixing anything. Rather, it is an invitation to allow oneself to be where one already is and to know the inner and outer landscape of the direct experience in each moment."

Try different types of mindfulness practice

Discovering the mindfulness practices best suited to your lifestyle and preferences can help you stay committed long-term. Fortunately, there are many different types of mindfulness and meditation practices. You may want to try a variety of activities, ranging from informal mindfulness during your daily commute to guided mindfulness meditation or physical yoga classes.

Use a mindfulness app

A number of mobile mindfulness apps exist, helping you learn mindfulness techniques and stay accountable. Many apps are free, with optional in-app purchases for additional features.

7 Lifestyle tips for better sleep

Studies have noted that certain lifestyle practices, collectively referred to as sleep hygiene, are correlated with superior sleep quality. The recommendations below outline common sleep hygiene practices that may help you achieve a better and more restorative night's sleep.

Follow a regular sleep schedule

Insomnia and poor sleep have been associated with an irregular sleep schedule. Establishing a regular bedtime routine, as well as consistent bedtimes and wake times can be helpful. A relaxing bedtime routine may include meditation, light stretching, a warm shower or bath, and **autonomous sensory meridian response (ASMR)** stimulation. ASMR is a sensory experience triggered by auditory or visual stimuli. It is characterized by a calming "tingling" feeling in the neck or scalp areas.

Create an environment conducive to better sleep

Excess noise in the bedroom should be reduced as it may increase nighttime arousals and contribute to insomnia. Engaging in highly demanding activities or using screens (e.g., TV, cellphones, computers) in the bedroom should also be avoided. A proper mattress and pillow, a comfortable

temperature (e.g., between 60 and 67 degrees), humidifiers, fans or "white noise" machines, earplugs, and blackout curtains are all techniques that may contribute to a more comfortable and relaxing environment.

Avoid stimulants & other substances that may impair sleep

Consuming caffeine, nicotine, and alcohol, particularly close to bedtime, may contribute to sleep difficulties. The effects of caffeinated beverages, such as black tea, coffee, and soda, may last several hours after intake. Citrus fruit and very heavy, rich, or spicy foods may also contribute to sleep disruption in some individuals prone to digestive issues when consumed close to bedtime. Sleep disturbances may also occur as a side-effect of certain over-the-counter medications.

Did you know?

ASMR stands for autonomous sensory meridian response.

Avoid napping during the day

Daytime naps may result in difficulties falling asleep and fragmented sleep patterns, which may contribute to sleep deprivation and insomnia. If a nap is required, the National Sleep Foundation recommends limiting daytime naps to a maximum of 30 minutes.

Ensure adequate exposure to sunlight

Exposure to natural light and darkness helps to regulate healthy sleep-wake cycles. Additionally, vitamin D deficiency has been associated with sleep disorders and symptoms, such as short sleep duration, poor sleep quality, and sleepiness. Allowing natural light in the house and spending time outdoors during the day, even in colder climates, may help reduce the risk of vitamin D deficiency, improve sensitivity to light, and help synchronize the body's circadian rhythms.

Engage in regular physical activity

Regular exercise may help improve sleep in both healthy individuals and those with sleep concerns. Although some sleep recommendations suggest that exercise too close to bedtime may interfere with sleep, research in healthy individuals has found

that nighttime exercise did not disrupt sleep. For exercise recommendations, refer to the physical activity guidelines in the 'Resources' section.

Incorporate stress management & relaxation techniques

Psychosocial stress has been shown to negatively impact sleep. To minimize exposure to stress, incorporate stress management and relaxation techniques, such as:

- Accepting imperfection
- Balancing time between work and rest
- Changing negative thought patterns (e.g., through cognitive behavioral therapy (CBT))
- Engaging in regular physical activity, at least 30 minutes, three to four times per week (e.g., biking, hiking, jogging, stretching)
- Establishing a daily routine and priorities
- Finding ways to communicate emotions and concerns
- Maintaining a balanced diet
- Setting realistic goals
- Utilizing body relaxation exercises (e.g., mindful breathing, progressive muscle relaxation)



Physical activity guidelines

Population	Type of activity	Activity frequency	Activity duration (minimum)
Children 3 to 5	Active play (variety of activities)	Daily	Unlimited throughout the day
Children 6 to 17	Aerobic	Daily	60 minutes /day; aerobic activity should make up most of the 60 minutes
	Muscle-strengthening	3 or more days /week	
	Bone-strengthening	3 or more days /week	
Adults	Moderate intensity aerobic	Spread throughout the week	150 to 300 minutes /week
	Muscle-strengthening; involving all major muscle groups	2 or more days /week	
Older adults	A combination of: Balance training, aerobic activity, muscle-strengthening, and bone-strengthening	Spread throughout the week	150 minutes /week
	Intensity should be determined by individual level of fitness		

The information provided in this table is based on recommendations from U.S. Department of Health and Human Services Physical Activity Guidelines for Americans, 2nd edition. Please note that individual recommendations may vary depending on health status, life events (e.g., pregnancy), and health conditions.

Physical activity examples

- **Balance training:** tai chi, yoga, pilates, using a stability ball or balance board
- **Aerobic activities:** brisk walking, jogging, dancing, swimming, tennis, cycling, ice skating
- **Bone-strengthening activities:** jumping jacks, jumping rope, lifting weights, skipping, running
- **Muscle-strengthening activities:** lifting weights, hiking, climbing stairs, working with resistance bands, body weight exercises (e.g., pushups, squats)

Grocery shopping list

The following list includes foods that should be favored to support immune health. This list can be printed and used as a resource when shopping.

Vegetables

- Artichoke
- Asparagus
- Beets
- Bok choy
- Broccoli
- Brussels sprouts
- Cabbage
- Carrots
- Cauliflower
- Celery
- Chard
- Collards
- Cucumbers
- Endives
- Fennel
- Garlic
- Green beans
- Kale
- Leek
- Okra
- Onion
- Oyster mushrooms
- Parsnips
- Peas
- Pumpkin
- Radishes
- Shiitake mushrooms
- Sweet potatoes
- Turnips, turnip greens
- Watercress
- Button mushrooms
- Yams
- Zucchini

Fruits

- Apples
- Bell peppers
- Blueberries
- Goji berries
- Grapefruit
- Grapes
- Kiwi
- Lemon
- Orange
- Raspberries
- Strawberries
- Tomatoes

Grains, pseudograins & flours

- Amaranth
- Barley
- Brown rice
- Buckwheat
- Farro
- Oats
- Quinoa
- Whole wheat

Beans & legumes

- Adzuki beans
- Black beans
- Black-eyed peas
- Fava beans
- Garbanzo beans
- Kidney beans.
- Lentils
- Peanuts
- Pinto beans
- Soybeans
- Split peas
- Tofu

Nuts & seeds

- Almonds
- Brazil nuts
- Cashews
- Chia seeds
- Flaxseeds
- Hazelnuts
- Macadamia nuts
- Pumpkin seeds
- Spinach
- Sunflower seeds
- Walnuts

Oils

- Cod liver oil
- Extra virgin avocado oil
- Extra virgin olive oil
- Virgin coconut oil

Meat, eggs, fish & shellfish

- Beef, beef liver
- Chicken
- Eggs
- Crab
- Herring
- Lobster
- Mackerel
- Oyster
- Pork
- Salmon
- Sardines
- Swordfish
- Tuna
- Trout

Fermented foods

- Kefir
- Kimchi
- Kombucha
- Miso
- Pickled vegetables (unpasteurized)
- Sauerkraut
- Tempeh
- Yogurt

Herbs & spices

- Anise
- Basil
- Black pepper
- Caraway
- Cayenne pepper
- Cinnamon
- Clove
- Cumin
- Fenugreek
- Garlic
- Ginger
- Mint
- Oregano
- Peppermint
- Rosemary
- Sage
- Thyme
- Turmeric

Teas

- Chamomile
- Dandelion root
- Ginger
- Green tea
- Lavender
- Nettle
- Oolong tea
- Peppermint
- Rooibos
- Thistle
- Turmeric
- White tea

Notes

EWG's clean fifteen & dirty dozen



Buying organic produce can help decrease your exposure to herbicides and pesticides. Consulting the 2020 Clean Fifteen and Dirty Dozen lists can help you make healthier choices when choosing your produce. This list, released annually by the Environmental Working Group (EWG), identifies fruits and vegetables with the highest and lowest pesticide residue.



✂ Cut me out and keep me in your wallet!

Dietary components to support immune health

When studied in isolation, the dietary components in the following table have been shown to have immune-supportive effects. While dietary sources provide a smaller amount of each component, consuming a variety of foods listed in the table may help support immune health.

Component	Function	Dietary sources
Epigallocatechin-3-gallate (EGCG)	May modulate adaptive and innate immunity; has anti-inflammatory effects; may play a role in preventing certain autoimmune conditions	Green tea, oolong tea, white tea
Omega-3 fatty acids	Inhibit production of inflammatory compounds; may mediate processes involved in immune cell activation	Fish, flaxseeds, chia seeds, walnuts, oysters
Probiotics	May inhibit the growth of pathogens, modulate the innate and adaptive immune responses, and reduce the risk of respiratory infections (e.g., the common cold, flu)	Fermented foods: yogurt, kefir, kombucha, sauerkraut, kimchi, unpasteurized pickled vegetables, miso, tempeh
Quercetin	Shown to reduce the incidence and severity of upper respiratory tract infection symptoms; may have additional anti-oxidant effects when combined with vitamin C	Onion, Brassica vegetables (e.g., broccoli, kale), tea, berries, apple, tomatoes, grapes
Vitamin C	Supports immune function; may prevent and treat upper respiratory tract infections	Citrus fruit, kiwi, strawberries, bell peppers, Brussels sprouts, broccoli
Vitamin D	Modulates the innate and adaptive immune response; enhances the anti-microbial effect of certain immune cells	Fish, beef liver, cod liver oil, eggs (egg yolks in particular are an excellent source)
Vitamin E	Protects immune cells from oxidative damage; may protect against certain infections, however, findings are inconsistent	Nuts, sunflower seeds, peanuts, spinach, broccoli
Zinc	Required to activate certain immune cells; deficiency is associated with impaired immune function and increased risk of infections such as pneumonia in certain groups	Seafood, beef, pork, chicken (dark meat), pumpkin seeds, yogurt, cashews, chickpeas

References

1. Ali, T., Bronze, M., Kaitha, S., Mahmood, S., Ffaisi, A., & Stone, J. (2013). Clinical use of anti-TNF therapy and increased risk of infections. *Drug, Healthcare and Patient Safety*, 79–99.
2. Anaya, J.-M., Ramirez-Santana, C., Alzate, M. A., Molano-Gonzalez, N., & Rojas-Villarraga, A. (2016). The autoimmune ecology. *Frontiers in Immunology*, 7, 139.
3. Anderson, J. W., Baird, P., Davis Jr, R. H., Ferreri, S., Knudtson, M., Koraym, A., ... Williams, C. L. (2009). Health benefits of dietary fiber. *Nutrition Reviews*, 67(4), 188–205.
4. Arreola, R., Quintero-Fabián, S., López-Roa, R. I., Flores-Gutiérrez, E. O., Reyes-Grajeda, J. P., Carrera-Quintanar, L., & Ortuño-Sahagún, D. (2015). Immunomodulation and anti-inflammatory effects of garlic compounds. *Journal of Immunology Research*, 2015, 1–13.
5. Azad, Md. A. K., Sarker, M., & Wan, D. (2018). Immunomodulatory effects of probiotics on cytokine profiles. *BioMed Research International*, 2018, 1–10.
6. Baik, I., Curhan, G. C., Rimm, E. B., Bendich, A., Willett, W. C., & Fawzi, W. W. (2000). A Prospective study of age and lifestyle factors in relation to community-acquired pneumonia in US men and women. *Archives of Internal Medicine*, 160(20), 3082–3088.
7. Besedovsky, L., Lange, T., & Born, J. (2011a). Sleep and immune function. *Pflügers Archiv - European Journal of Physiology*, 463(1), 121–137.
8. Besedovsky, L., Lange, T., & Born, J. (2011b). Sleep and immune function. *Pflügers Archiv - European Journal of Physiology*, 463(1), 121–137.
9. Bhagwat, S., Haytowitz, D. B., & Holden, J. M. (2014, May 1). USDA database for the flavonoid content of selected foods. Retrieved from https://www.ars.usda.gov/ARSDocuments/80400525/Data/Flav/Flav_R03-1.pdf
10. Bøyum, A., Wilk, P., Gustavsson, E., Veiby, O. P., Reseland, J., Haugen, A. H., & Opstad, P. K. (1996). The effect of strenuous exercise, calorie deficiency and sleep deprivation on white blood cells, plasma immunoglobulins and cytokines. *Scandinavian Journal of Immunology*, 43(2), 228–235.
11. Calder, P. C. (2017). Omega-3 fatty acids and inflammatory processes: from molecules to man. *Biochemical Society Transactions*, 45(5), 1105–1115.
12. Campbell, J. P., & Turner, J. E. (2018). Debunking the myth of exercise-induced immune suppression: Redefining the impact of exercise on immunological health across the lifespan. *Frontiers in Immunology*, 9, 648.
13. Cano RLE, Lopera HDE.(2013). Introduction to T and B lymphocytes. In: Anaya JM, Shoenfeld Y, Rojas-Villarraga A, et al., editors. *Autoimmunity: From Bench to Bedside* [Internet]. Bogota (Colombia): El Rosario University Press. Chapter 5. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK459471/>
14. Cao Dinh, H., Beyer, I., Mets, T., Onyema, O. O., Njemini, R., Renmans, W., ... Bautmans, I. (2016). Effects of physical exercise on markers of cellular immunosenescence: A systematic review. *Calcified Tissue International*, 100, 193–215.

15. Centers for Disease Control and Prevention. (2020, February 11). Cleaning and disinfecting your home. Retrieved from <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/disinfecting-your-home.html>
16. Chang, S.-W., & Lee, H.-C. (2019). Vitamin D and health – The missing vitamin in humans. *Pediatrics & Neonatology*, 60(3), 237–244.
17. Chaplin, D. D. (2010). Overview of the immune response. *Journal of Allergy and Clinical Immunology*, 125(2), S3–S23.
18. ChooseMyPlate. (n.d.). All about oils. Retrieved from <https://www.choosemyplate.gov/eathealthy/oils>
19. Christensen, M. A., Bettencourt, L., Kaye, L., Moturu, S. T., Nguyen, K. T., Olgin, J. E., ... Marcus, G. M. (2016). Direct measurements of smartphone screen-time: Relationships with demographics and sleep. *PLoS One*, 11(11), e0165331.
20. Cohen, M. (2007). Environmental toxins and health--the impact of pesticides. *Aust Fam Physician*, 36(12), 1002–1004.
21. Cohen, S., Doyle, W. J., Alper, C. M., Janicki-Deverts, D., & Turner, R. B. (2009). Sleep habits and susceptibility to the common cold. *Archives of Internal Medicine*, 169(1), 62–67.
22. Corsini, E., Liesivuori, J., Vergieva, T., Van Loveren, H., & Colosio, C. (2008). Effects of pesticide exposure on the human immune system. *Human & Experimental Toxicology*, 27(9), 671–680.
23. Coutinho, A. E., & Chapman, K. E. (2011). The anti-inflammatory and immunosuppressive effects of glucocorticoids, recent developments and mechanistic insights. *Molecular and Cellular Endocrinology*, 335(1), 2–13.
24. Davis, C., Bryan, J., Hodgson, J., & Murphy, K. (2015). Definition of the Mediterranean diet; A literature review. *Nutrients*, 7(11), 9139–9153. <https://doi.org/10.3390/nu7115459>
25. Dhabhar, F. S. (2009). Enhancing versus suppressive effects of stress on immune function: Implications for immunoprotection and immunopathology. *Neuroimmunomodulation*, 16(5), 300–317.
26. Dhabhar, F. S. (2018). The short-term stress response – Mother nature’s mechanism for enhancing protection and performance under conditions of threat, challenge, and opportunity. *Frontiers in Neuroendocrinology*, 49, 175–192.
27. Eijkelkamp, B. A., Morey, J. R., Neville, S. L., Tan, A., Pederick, V. G., Cole, N., ... McDevitt, C. A. (2019). Dietary zinc and the control of *Streptococcus pneumoniae* infection. *PLOS Pathogens*, 15(8), e1007957.
28. Environmental Working Group. (2020 25). EWG’s 2020 shopper’s guide to pesticides in produce. Retrieved from <https://www.ewg.org/foodnews/summary.php>
29. Fietze, I., Barthe, C., Hölzl, M., Glos, M., Zimmermann, S., Bauer-Diefenbach, R., & Penzel, T. (2016). The effect of room acoustics on the sleep quality of healthy sleepers. *Noise and Health*, 18(84), 240–246.
30. Glantz, S. A., & Bareham, D. W. (2018). E-Cigarettes: Use, effects on smoking, risks, and policy implications. *Annual Review of Public Health*, 39(1), 215–235.
31. Goldman D. (2000). Chronic lymphocytic leukemia and its impact on the immune system. *Clin J Oncol Nurs*, 4(5), 233–234.
32. Gombart, A. F. (2009). The vitamin D–antimicrobial peptide pathway and its role in protection against infection. *Future Microbiology*, 4(9), 1151–1165.
33. Gross, C. R., Kreitzer, M. J., Reilly-Spong, M., Wall, M., Winbush, N. Y., Patterson, R., ... Cramer-Bornemann, M. (2011). Mindfulness-based stress reduction versus pharmacotherapy for chronic primary insomnia: A randomized controlled clinical trial. *EXPLORE*, 7(2), 76–87.

34. Haddad, P. S., Azar, G. A., Groom, S., & Boivin, M. (2005). Natural health products, modulation of immune function and prevention of chronic diseases. *Evidence-Based Complementary and Alternative Medicine*, 2(4), 513–520.
35. Hao, Q., Dong, B. R., & Wu, T. (2015). Probiotics for preventing acute upper respiratory tract infections. *Cochrane Database of Systematic Reviews*.
36. Heinz, S. A., Henson, D. A., Austin, M. D., Jin, F., & Nieman, D. C. (2010). Quercetin supplementation and upper respiratory tract infection: A randomized community clinical trial. *Pharmacological Research*, 62(3), 237–242.
37. Hemilä, H., & Chalker, E. (2013a). Vitamin C for preventing and treating the common cold. *Cochrane Database of Systematic Reviews*.
38. Iijima, H., Shinzaki, S., & Takehara, T. (2012). The importance of vitamins D and K for the bone health and immune function in inflammatory bowel disease. *Current Opinion in Clinical Nutrition and Metabolic Care*, 15(6), 635–640.
39. Institute for Quality and Efficiency in Health Care (IQWiG). (2016) The innate and adaptive immune systems. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK279396/>
40. Institute for Quality and Efficiency in Health Care (IQWiG). (2006) What are the organs of the immune system? Retrieved from: <https://www.ncbi.nlm.nih.gov/books/NBK279395/>
41. Irish, L. A., Kline, C. E., Gunn, H. E., Buysse, D. J., & Hall, M. H. (2015). The role of sleep hygiene in promoting public health: A review of empirical evidence. *Sleep Medicine Reviews*, 22, 23–36.
42. Janeway, C. A., Jr. (2020). Extrinsic regulation of unwanted immune responses. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK27143/>
43. Jayachandran, M., Xiao, J., & Xu, B. (2017). A critical review on health promoting benefits of edible mushrooms through gut microbiota. *International Journal of Molecular Sciences*, 18(9), 1934.
44. Kan, L., Nie, S., Hu, J., Wang, S., Cui, S. W., Li, Y., ... Xie, M. (2017). Nutrients, phytochemicals and antioxidant activities of 26 kidney bean cultivars. *Food and Chemical Toxicology*, 108(Pt B), 467–477.
45. Kunnumakkara, A. B., Bordoloi, D., Padmavathi, G., Monisha, J., Roy, N. K., Prasad, S., & Aggarwal, B. B. (2016). Curcumin, the golden nutraceutical: Multitargeting for multiple chronic diseases. *British Journal of Pharmacology*, 174(11), 1325–1348.
46. Lee, G., & Han, S. (2018). The role of vitamin E in immunity. *Nutrients*, 10(11), 1614.
47. Li, Y., Yao, J., Han, C., Yang, J., Chaudhry, M., Wang, S., ... Yin, Y. (2016). Quercetin, inflammation and immunity. *Nutrients*, 8(3), 167.
48. Maggini, S., Pierre, A., & Calder, P. (2018). Immune function and micronutrient requirements change over the life course. *Nutrients*, 10(10), 1531.
49. Maldonado Galdeano, C., Cazorla, S. I., Lemme Dumit, J. M., Vélez, E., & Perdígón, G. (2019). Beneficial effects of probiotic consumption on the immune system. *Annals of Nutrition and Metabolism*, 74(2), 115–124.
50. Mashhadi, N. S., Ghiasvand, R., Askari, G., Hariri, M., Darvishi, L., & Mofid, M. R. (2013). Anti-oxidative and anti-inflammatory effects of ginger in health and physical activity: Review of current evidence. *International Journal of Preventative Medicine*, 4(1), S36–S42.
51. Montecino-Rodriguez, E., Berent-Maoz, B., & Dorshkind, K. (2013). Causes, consequences, and reversal of immune system aging. *Journal of Clinical Investigation*, 123(3), 958–965.

52. Mora, J. R., Iwata, M., & von Andrian, U. H. (2008). Vitamin effects on the immune system: Vitamins A and D take centre stage. *Nature Reviews Immunology*, 8(9), 685–698.
53. Morey, J. N., Boggero, I. A., Scott, A. B., & Segerstrom, S. C. (2015). Current directions in stress and human immune function. *Current Opinion in Psychology*, 5, 13–17.
54. Myles, I. A. (2014a). Fast food fever: Reviewing the impacts of the Western diet on immunity. *Nutrition Journal*, 13(1).
55. National Institutes of Health. (2019, October 17). Omega 3 fatty acids. Retrieved from <https://ods.od.nih.gov/factsheets/Omega3FattyAcids-HealthProfessional/>
56. National Institutes of Health. (2020, February 27). Vitamin C. Retrieved from <https://ods.od.nih.gov/factsheets/VitaminC-HealthProfessional/>
57. National Institutes of Health. (2020, March 24). Vitamin D. Retrieved from <https://ods.od.nih.gov/factsheets/VitaminD-HealthProfessional/>
58. National Institutes of Health. (2020, February 28). Vitamin E. Retrieved from <https://ods.od.nih.gov/factsheets/VitaminE-HealthProfessional/>
59. National Institutes of Health. (2020, March 6). Zinc. Retrieved from <https://ods.od.nih.gov/factsheets/Zinc-HealthProfessional/>
60. Nieman, D. C., & Pedersen, B. K. (1999). Exercise and immune function. *Sports Medicine*, 27(2), 73–80.
61. Noroozi, M., Angerson, W. J., & Lean, M. E. (1998). Effects of flavonoids and vitamin C on oxidative DNA damage to human lymphocytes. *The American Journal of Clinical Nutrition*, 67(6), 1210–1218.
62. Office of Disease Prevention and Health Promotion. (2020). Current Guidelines. Retrieved from <https://health.gov/our-work/physical-activity/current-guidelines>
63. Peumans, W. J., & Van Damme, E.J.M. (1995). Lectins as plant defense proteins. *Plant Physiology*, 109(2), 347–352.
64. Polhuis, K., Wijnen, A., Sierksma, A., Calame, W., & Tieland, M. (2017). The diuretic action of weak and strong alcoholic beverages in elderly men: A randomized diet-controlled crossover trial. *Nutrients*, 9(7), 660.
65. Popkin, B. M., D’Anci, K. E., & Rosenberg, I. H. (2010). Water, hydration, and health. *Nutrition Reviews*, 68(8), 439–458.
66. Prasad, A. S., Beck, F. W., Bao, B., Fitzgerald, J. T., Snell, D. C., Steinberg, J. D., & Cardozo, L. J. (2007). Zinc supplementation decreases incidence of infections in the elderly: Effect of zinc on generation of cytokines and oxidative stress. *The American Journal of Clinical Nutrition*, 85(3), 837–844.
67. Qiu, F., Liang, C.-L., Liu, H., Zeng, Y.-Q., Hou, S., Huang, S., ... Dai, Z. (2016). Impacts of cigarette smoking on immune responsiveness: Up and down or upside down? *Oncotarget*, 8(1).
68. Ran, L., Zhao, W., Wang, J., Wang, H., Zhao, Y., Tseng, Y., & Bu, H. (2018). Extra dose of vitamin C based on a daily supplementation shortens the common cold: A meta-analysis of 9 randomized controlled trials. *BioMed Research International*, 2018, 1–12.
69. Reverri, E., Randolph, J., Steinberg, F., Kappagoda, C., Edirisinghe, I., & Burton-Freeman, B. (2015). Black beans, fiber, and antioxidant capacity pilot study: Examination of whole foods vs. functional components on postprandial metabolic, oxidative stress, and inflammation in adults with metabolic syndrome. *Nutrients*, 7(8), 6139–6154.
70. Rezac, S., Kok, C. R., Heermann, M., & Hutkins, R. (2018). Fermented foods as a dietary source of live organisms. *Frontiers in Microbiology*, 9.
71. Salam, N., Rane, S., Das, R., Faulkner, M., Gund, R., Kandpal, U., ... Bal, V. (2013). T cell

- ageing: Effects of age on development, survival & function. *Indian J Med Res.*, 138(5), 595–608.
72. Sears, M. E., & Genus, S. J. (2012). Environmental determinants of chronic disease and medical approaches: Recognition, avoidance, supportive therapy, and detoxification. *Journal of Environmental and Public Health*, 2012, 1–15.
 73. Shi, N., Li, N., Duan, X., & Niu, H. (2017). Interaction between the gut microbiome and mucosal immune system. *Military Medical Research*, 4(1), 14.
 74. Tähkämö, L., Partonen, T., & Pesonen, A.-K. (2018). Systematic review of light exposure impact on human circadian rhythm. *Chronobiology International*, 36(2), 151–170.
 75. U.S. Department of Health and Human Services. (2020). Smoking cessation: A report of the surgeon general. Retrieved from <https://www.hhs.gov/sites/default/files/2020-cessation-sgr-full-report.pdf>
 76. Vaillant, J. A. A. (2019). Physiology, immune response. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK539801/>
 77. Valverde, M. E., Hernández-Pérez, T., & Paredes-López, O. (2015). Edible mushrooms: Improving human health and promoting quality life. *International Journal of Microbiology*, 2015, 1–14.
 78. Wade, A. T., Davis, C. R., Dyer, K. A., Hodgson, J. M., Woodman, R. J., & Murphy, K. J. (2018). A Mediterranean diet supplemented with dairy foods improves markers of cardiovascular risk: Results from the MedDairy randomized controlled trial. *The American Journal of Clinical Nutrition*, 108(6), 1166–1182.
 79. Wasser, S. (2014). Medicinal mushroom science: Current perspectives, advances, evidences, and challenges. *Biomedical Journal*, 37(6), 345–356.
 80. Weng, N. (2006). Aging of the immune system: How much can the adaptive immune system adapt? *Immunity*, 24(5), 495–499.
 81. Wu, D., Lewis, E. D., Pae, M., & Meydani, S. N. (2019). Nutritional modulation of immune function: Analysis of evidence, mechanisms, and clinical relevance. *Frontiers in Immunology*, 9, 3160.
 82. Zanovec, M., O'Neil, C. E., & Nicklas, T. A. (2011). Comparison of nutrient density and nutrient-to-cost between cooked and canned beans. *Food and Nutrition Sciences*, 02(02), 66–73.
 83. Zgierska, A. E., Burzinski, C. A., Cox, J., Kloke, J., Stegner, A., Cook, D. B., ... Bačkonja, M. (2016). Mindfulness meditation and cognitive behavioral therapy intervention reduces pain severity and sensitivity in opioid-treated chronic low back pain: Pilot findings from a randomized controlled trial. *Pain Medicine*, 17(10), 1865–1881.



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