

Immune System Strengthening

Age, stress, and poor nutrition can sap our immune system of its effectiveness. Influenza provides one example. During young adulthood, when the body can mount a robust immune response to this common virus, influenza is rarely fatal. Among the elderly, however, the virus is associated with significant rates of death and hospitalization (Nichol KL 2005).

The impact of aging on the immune system is profound. As people age, a number of critical immune system components are reduced or slowed, including cellular response, response to vaccines, and antibody production. At the same time, susceptibilities to infection and cancer are increased. Some of this increased susceptibility to disease is linked to chronic inflammation, which is associated with many disorders of aging (Ershler WB et al 2000; Hamerman D 1999; Taaffe DR et al 2000).

Age, however, isn't the sole culprit in reduced immune function. There is no question that exercise, stress, and nutritional status play an important role in maintaining a healthy immune system. Consider just a few of the research findings:

- Dietary deficiencies and malabsorption alter metabolism and exacerbate chronic disorders (Kaput J et al 2004). An imbalance in the intake of dietary fat, carbohydrate, and protein can contribute to the development of diseases (Kaput J et al 2004). On the other hand, there is overwhelming evidence of the benefits of a good diet on reducing the risk of many chronic diseases (Ames BN 2001; Kaput J et al 2004).
- Malnutrition causes a decline in immune function and increased susceptibility to infection (Brussow H et al 1995; Lotfy O et al 1998; delaFuente M et al 1998). Likewise, a vitamin or mineral deficiency can suppress immune system function (delaFuente M et al 1998). Correct choices of supplements, vitamins, minerals, fatty acids, probiotics, and botanicals have been shown to boost immunity and may also reduce the risk of diseases in healthy individuals (Kaminogawa S et al 2004).
- Psychological health influences the immune system and the course of many diseases (Kiecolt-Glaser J et al 2000). Depression, stress, and anxiety increase the production of pro-inflammatory chemicals in the blood, which in turn can compromise, depress, or suppress the immune system (Appels A et al 2000; Dentino AN et al 1999; Maes M et al 1997; Maes M et al 1998; Maes M et al 1999; Boscarino JA et al 1999; Lutgendorf SK et al 1999; Zhou D et al 1993; Papanicolaou DA et al 1998).
- High levels of anxiety are associated with decreased immune function (Ironson G et al 1990; Koh KB et al 1998; Boscarino JA et al 1999; Kiecolt-Glaser J et al 2000).
- Chronic stress can provoke long-term increases in pro-inflammatory chemicals. For example, caregiving for a relative with a serious medical condition results in long-term immune suppression among women (Lutgendorf SK et al 1999).
- Chronic stress from persistent marital problems, burnout at work (Lerman Y et al 1999), and lengthy unemployment (Arnetz BB et al 1991) can also lead to immune alterations that persist for years (Boscarino JA et al 1999; Kiecolt-Glaser JK et al 1987; Kiecolt-Glaser JK et al 1997; Kiecolt-Glaser JK et al 1988; Kiecolt-Glaser JK et al 1993).

Life Extension believes that all aging people should take prospective action to bolster their immune systems. This means reducing negative psychological stress; following a physician-approved, moderate, long-term exercise program; and following a diet and consuming nutrients that have been shown to enhance the immune response and promote health.

THE IMMUNE SYSTEM: HOW IT WORKS

The immune system is an elegant and complex set of components that combine to fight disease, infections, and various pathogens. A healthy immune system distinguishes organisms in the body as “self” or “non-self.” An intact immune response identifies pathogens as “non-self” and rapidly destroys them. A depressed immune system, by contrast, will allow invading organisms to flourish.

Furthermore, when the immune system mistakenly recognizes a “self” cell as “non-self” and mounts an immune response, the result is an autoimmune disorder such as rheumatoid arthritis.

In general, the body has two primary defense mechanisms: natural immunity and acquired immunity. Natural immunity is the “first responder” to an attack. The natural immune response relies on various white blood cells and physical barriers to block or immediately attack any foreign invader and attempt to destroy it.

Acquired immunity, on the other hand, involves antibodies that are created in response to specific foreign antigens. This sort of response requires a few days for the body to recognize the invader and manufacture antibodies against it. Once the body has manufactured a particular antibody for a specific invader, the immune system response is faster and more effective the next time

that invader appears (Janeway CA et al 1999; Beers MB 2004).

The natural immune system relies on a host of weapons to protect the body, including various kinds of white blood cells (see Table 1). These natural defenses include the following organs, chemicals, and processes:

Physical and chemical barriers. The body's first lines of defense are the skin and mucous membranes, which prevent the entrance of many pathogens. There are many secondary barriers. For example, tears, sweat, and saliva combat some bacteria, and the hydrochloric acid and protein-digesting enzymes secreted by the stomach are lethal to many, but not all, pathogens (Janeway CA et al 1999; Beers MB 2004).

Inflammation and fever. Inflammation is a nonspecific response to infection or tissue injury. The four signs of the inflammatory response are redness, swelling, heat, and pain. Inflammation begins when cells release certain cytokines, including interleukin (IL)-1, IL-6, and tumor necrosis factor-alpha (TNF-alpha) (Janeway CA et al 1999; Beers MB 2004).

Phagocytic cells. Phagocytic cells engulf foreign cells and destroy them. The phagocytic cells are white blood cells and include neutrophils, eosinophils, and macrophages; they have short lives and must be continually replenished by the body. Neutrophils and macrophages are a very important aspect of the innate defenses of the body (Janeway CA et al 1999; Beers MB 2004).

Natural killer cells. Natural killer cells destroy certain cancer cells and a variety of pathogens. Killer cells are active secretors of interferon, an important and potent protein. Natural killer cells attach directly to the surfaces of infected cells and cause them to burst. They can also kill a pathogen by making its outer membrane leak (Janeway CA et al 1999; Beers MB 2004).

Antimicrobial proteins. Infected immune cells produce interferon, which causes healthy cells to produce antiviral proteins. There are more than 30 distinct antiviral proteins. When an individual complement (immune system) protein is activated by infecting organisms, it triggers a cascade that activates other complement proteins. Activated proteins can destroy bacteria while sparing host cells or cause the infected cells to become engulfed by phagocytic cells (Janeway CA et al 1999; Beers MB 2004).

Cytokines. To communicate and share information, cells use chemicals. Each chemical sends a different message to other cells. These chemical messengers are called cytokines. Cytokines regulate immunity, inflammation, and the production of white blood cells. There are dozens of cytokines; each performs a specific set of activities against specific target cells. They can act in concert or in opposition. Cytokines are often produced in a cascade; in other words, a cytokine stimulates its target cells to make additional cytokines. TNF-alpha, IL-1, IL-6, and type I interferon are important cytokines in the regulation of natural immunity.

Acute-phase proteins. The acute-phase response is activated during critical illnesses. When phagocytic cells bind pathogens, they release pro-inflammatory cytokines. This response enables the body to recognize invaders before the immune responses have been fully activated. Acute-phase proteins promote inflammation and stimulate phagocytes to move where they are needed.

Table 1. Major Cells of the Immune System (Janeway CA et al 1999; Nairn R 2000)

Cell	Activity
Lymphocytes	
Natural killer cells	Destroy a variety of tumor cells and antibody-coated target cells; not antigen specific.
Cytotoxic T (CD8+) cells	Secrete cytokines that attract macrophages and increase their phagocytic activity; destroy target cells that display the same antigen that activated their progenitor cell; lyse infected cells by releasing toxins. Cytotoxic T cells fight foreign invaders by destroying cells that display the antigen that activated its progenitor cells (immunological surveillance).
Helper T (T4+) cells	Stimulate cellular immunity and inflammation; secrete cytokines that stimulate proliferation of B cells and other T cells; amplify antibody production by plasma cells.
Suppressor T cells	Suppress activity of naïve (unstimulated) and effector T cells.
Memory T cells	Recognize antigens that have invaded in the past, which allows for a larger and more rapid response when there is a second encounter with that antigen.
B lymphocytes (B cells)	Differentiate into antibody-producing plasma cells; process and present antigen to helper T cells; display immunoglobulin and class II MHC antigens.
Plasma cells	Main antibody-secreting cells.
Memory B cells	Descendants of B cells that remain after an immune response.
Phagocytes	
Macrophages	Phagocytize antigens, then process and present them to T cells for destruction; attack dead and defective blood cells; secrete cytokines that induce proliferation of B and T cells.
Neutrophils	Major defense against bacteria; first on scene to fight infection.
Eosinophils	Active against parasites and commonly elevated in allergies.
Dendritic cells (interdigitating reticular cells)	Process and present antigen to T and B cells; most potent stimulators of T cell responses.

Antigen-presenting cells Engulf antigens, process them internally, and then display fragments of them on their surface; surface markers alert other immune cells that there is an invader. Identified antigen-presenting cells: dendritic cells, macrophages, and B lymphocytes.

INFLAMMATION, FREE RADICALS, AND CYTOKINES

Although acute inflammation is an important immune system response, chronic inflammation has also been linked to many diseases, including heart disease. Besides the pro-inflammatory cytokines, inflammation may be related to the overproduction of free radicals (Janeway CA et al 1999).

A free radical is an atom or group of atoms (i.e., a molecule) with unpaired electrons. Free radicals are extremely unstable and react easily with other molecules, thereby changing their chemical composition. Oxygen is especially susceptible to free radical formation. The free radicals derived from oxygen are known as reactive oxygen species, or oxidants.

When the body has increased levels of reactive oxygen species (i.e., when it is experiencing oxidative stress), widespread damage may result. At high concentrations free radicals can damage fats, proteins, and nucleic acids. They can also cause cell death, gene mutations, and cancer (Moslen MT 1994). Several diseases may be the result of cellular and genetic damage caused by free radicals, including several immune disorders (Moslen MT 1994).

In order to reduce the damage caused by elevated free radicals and cytokines (which are both part of the natural immune system), the body fights back by producing antioxidants and hormones such as cortisol to suppress the immune system (Grimble RF 1996). Antioxidants are valuable because they pair with unstable free radicals, thereby limiting the damage free radicals can inflict on other cells.

What You Have Learned So Far...

- The immune system declines as we age, making us more susceptible to various diseases and pathogens.
- The immune system's health is closely related to stress, frequency of exercise, and nutritional status. Poor intake of vital nutrients is closely associated with a depressed immune response and an increased rate of disease.
- The immune system has two primary defense mechanisms: natural, which uses white blood cells and physical barriers to protect us from disease, and acquired, in which specialized cells generate antibodies to defend against specific pathogens.
- Inflammation is caused by multiple factors, including microorganisms, physical stress, tissue death, and inappropriate immune responses. Chronic inflammation is linked to diseases such as heart disease. Inflammation is mediated by cytokines and free radicals. It is an important immune system response, but it can also be dangerous because a chronic inflammatory state is linked to various diseases of aging.
- Free radicals are unstable molecules that readily react with other molecules, especially oxygen, to change their chemical composition. Antioxidants are used by the body to scavenge for free radicals and limit the amount of damage they can cause.

Nutrition, Immunity, and Your Genes

Have you ever noticed how some people seem never to get sick, but others are constantly battling colds and the flu? Researchers are just now beginning to understand how genes affect nutrition and overall immunity. It turns out that the overall risk of contracting many diseases is influenced by genetics (Mathew C 2001). A new field of nutritional genomics explores the interaction of nutrition, genes, and environmental factors, including diet (Kaput J et al 2004).

This emerging field of science evolved from the Human Genome Project, which mapped the human genome and identified many genes that cause disease.

The association between diet and chronic diseases such as atherosclerosis, diabetes, obesity, and cancer is well known (Jenkins DJ et al 1997; Jenkins DJ et al 1999; Jenkins DJ et al 2000; Kaput J et al 2004). Nutrients supplied by food are an important variable in gene expression. Deficiency of some essential nutrients can alter metabolism and the structure of DNA (Kaput J et al 2004). A well-studied example of the relationship between genetics and diet is type 2 diabetes. This condition is associated with a sedentary lifestyle, being overweight, and ethnicity. Although some individuals are genetically predisposed to this condition, many can control symptoms through exercise and a change in diet (Kaput J et al 2004).

In the future, genetic testing might be able to help physicians recommend specific, personal nutritional programs that are tailored to each individual's unique genetic makeup and that will help us fight disease and stay healthy.

SUPPORTING A HEALTHY IMMUNE SYSTEM

A healthy immune system grows ever more important as we age, and immune status is closely associated with nutrition, exercise, and stress reduction. Older people and people with compromised immune systems should talk to their physician about exercising, reducing stress, and designing an active, immune-boosting nutritional program.

Glutathione boosters. Glutathione is probably the body's most important cellular defense against free radical damage. It is a free radical scavenger and major antioxidant.

Low levels of glutathione are linked to many diseases. Malnutrition and aging (Cai J et al 2000) deplete glutathione. Glutathione is also involved in one of the major liver detoxification pathways.

Glutathione is produced in the body, and it is not easily absorbed when taken orally. Instead, glutathione precursors may be used by the body to increase glutathione (Bounous G 2000). Glutathione precursors include glutamine, N-acetylcysteine (NAC) , and S-adenosyl-L-methionine (SAME) (Devlin T 2002). It can also be upregulated by lipoic acid and vitamins C and E.

Glutamine. Glutamine is the most abundant amino acid in the body (Roth E 2002). Glutamine depletion causes downregulation of glutathione levels in the body (Roth E 2002), and dietary supplementation increases it (Roth E 2002). Glutamine has immunoregulative activities (Roth E 2002; Li J et al 1995). Lymphocytes and macrophages use glutamine at a very high rate (Newsholme E 1994). Glutamine stimulates lymphocyte production and killer immune cell activity (Rohde T et al 1995; Rohde T et al 1998; Rohde T et al 1996; Juretic A et al 1994).

Glutamine depletion slows wound healing and increases the risk of organ failure under certain conditions (Wilmore DW 1991). Endurance athletes whose muscles do not fully recover between workouts have decreased glutamine levels (Shephard RJ et al 1998; Castell LM et al 1998). Some scientists believe that intense physical exercise or stress due to trauma, burns, or sepsis (blood infection) forces the body into glutamine debt, which temporarily compromises immune function (Newsholme E 1994).

SAME. SAME is a natural amino acid present throughout the body. It is crucially important because it is involved in dozens of chemical reactions, including the synthesis of DNA and RNA, proteins, melatonin, creatine, and many others. SAME is an important energy source (Osman E et al 1993) and is intrinsically related to the synthesis of glutathione.

NAC. NAC acts as an antioxidant and is recommended for conditions that increase oxidative stress or decrease glutathione levels (Burgunder JM et al 1989). NAC has a protective effect on DNA and is a powerful free radical scavenger. It increases the synthesis of glutathione only when there is a demand and is thought to concentrate only in tissues where it is required (Burgunder JM et al 1989). NAC can modulate the concentrations of certain cytokines. In laboratory studies, it has increased IL-1 and IL-2 levels when they are at low concentrations and decreased these cytokines at higher concentrations (Baier JE et al 1996). It has also demonstrated an ability to inhibit cell growth and proliferation in cancer cell lines (Chiao JW et al 2000) and prevent the transformation of carcinogens into more toxic compounds (De Flora S 1984; Wilpart M et al 1986).

ANTIOXIDANTS AND COENZYME Q10

Because of their ability to scavenge free radicals, antioxidants are important immune-system boosters. Supplementation with antioxidants like vitamins C and E and the B vitamins may improve immune function (Grimble RF 1997), and supplementation with vitamin A stimulates antibody-mediated immune responses (Cantorna M et al 1995).

Vitamin E is a powerful fat-soluble antioxidant. It protects cellular membranes of the immune system and other cells by trapping free radicals and enhances the effectiveness of lymphocytes (Kaminogawa S et al 2004).

Vitamin C (ascorbic acid) is a key component of the immune system and antioxidant defense (Kagan VE et al 1991; Kagan VE et al 1992; Peters E et al 1993). It prevents the production of free radicals and reduces DNA damage in immune cells. Moreover, vitamin C downregulates the production of pro-inflammatory cytokines and participates in recycling vitamin E (Schwager J et al 1998).

B vitamins indirectly contribute to antioxidant defenses and have considerable influence on immune function. Vitamins B12 and B6 are cofactors in the creation of cysteine, a key component in glutathione synthesis. Deficiencies in B vitamins and vitamin E create abnormalities in the immune response (Murray R et al 2000).

Lipoic acid is a potent antioxidant with antiviral, free-radical-quenching, and immune-boosting qualities. It is unusual because it is soluble in both fat and water (Kagan VE et al 1992) and active in both its oxidized and reduced form (Bustamante J et al 1998). Lipoic acid is able to regenerate other antioxidants such as vitamins C and E and raise glutathione levels significantly (Packer L et al 1995; Packer L et al 1997; Scholich H et al 1989; Fuchs J et al 1993).

Coenzyme Q10 (CoQ10) is synthesized from the amino acid tyrosine. It is present in high quantities in the heart muscle and has shown a wide range of benefits. It is an essential cofactor in the production of adenosine triphosphate, which is the primary source of energy for all the body's cells. Levels of CoQ10 decline naturally as humans age, which may be related to increased lipid peroxidation. CoQ10 is a powerful antioxidant and scavenger of free radicals. It inhibits lipid peroxidation and works synergistically with vitamin E (Alleva R et al 1995). CoQ10 has an important role in the stimulation of the immune system and improves several parameters of immune function (Folkers K et al 1985).

Whey protein. Whey protein is isolated from milk. The proteins in whey are very available to the body, and whey protein contains potent antioxidants. Its antioxidant activity is due to its high concentrations of glutamate and cysteine, which are precursors to glutathione (Walzem RL et al 2002). Whey also contains several substances that enhance the immune system, including the following:

- Beta-lactoglobulin, which modulates lymphatic responses (Guimont C et al 1997)
- Alpha-lactalbumin, which has a direct effect on B and T lymphocytes and has the ability to reduce oxidative stress
- Lactoperoxidase, which reduces toxic hydrogen peroxide (Sundberg J et al 1991; Ha E et al 2003)

Lactoferrin, a major component of whey protein, also acts as an antioxidant (Steijns JM et al 2000) and can inhibit the absorption of bacteria through the intestinal wall. Whey protein can activate natural killer cells (Nishiya K et al 1982). In the laboratory, lactoferrin inhibited metastasis of cancer cells in mice (Marshall K 2004) and increased IL-2 and natural killer activity (Watanabe A et al 2000).

MINERALS

Metallic micronutrients such as copper, zinc (Prasad AS 2000), and selenium influence the activity of antioxidant enzymes and can reduce oxidative stress. Among children, deficiencies of zinc, copper, and selenium have been linked to immune deficiency and infection (Cunningham-Rundles S et al 2005).

Selenium is involved in several key metabolic pathways (Rotruck JT et al 1973; McKenzie RC et al 1998; McKenzie RC 2000). Glutathione peroxidase, the enzyme that recycles glutathione, depends on the presence of selenium for its antioxidant activity (Arthur JR 2003). Plant food is a major dietary source of selenium—for example, garlic is rich in selenium—while the highest concentration of dietary selenium occurs in meat.

Zinc deficiency is linked to impaired immune function, partly because of decreased T lymphocyte and B lymphocyte function. Zinc has shown the ability to decrease inflammation and the production of IL-2 (Tanaka S et al 2005). Copper and zinc together have been shown to stimulate internally produced antioxidants such as glutathione and superoxide dismutase (SOD) (Kuppusamy UR et al 2005).

For safety information on copper, zinc, and selenium, see Safety Caveats at the end of this chapter.

DHEA AND IMMUNE FUNCTION

Dehydroepiandrosterone, more commonly known as DHEA, is produced by the adrenal glands. DHEA has over 100 metabolites and is used by the body for estrogen and testosterone production.

Blood levels of DHEA rise until they peak in the third decade of life, then rapidly decline. Endocrinologists and anti-aging researchers have been focusing on this decrease in DHEA, which in turn produces a decline in other steroidal hormones.

Animal experiments suggest that DHEA has many biological effects, including anticancer, immune-enhancing, neurotrophic, and general anti-aging effects (Bovenberg SA et al 2005). A recently published review article of DHEA supplementation in men found convincing research showing positive effects of DHEA on the cardiovascular system, body composition, the skin, the central nervous system, sexual function, and the immune system (Saad F et al 2005).

On the cellular level, DHEA exerts its actions on peripheral target tissues either indirectly, following its conversion to androgens, estrogens, or both, or directly, as a steroid hormone (Perrini et al 2005). Lower DHEA levels are associated with decreased production of IL-2 and an increase in the presence of IL-6, which is a pro-inflammatory cytokine (Hammer F et al 2005). A study was performed on younger and older men to compare DHEA blood levels and peripheral blood mononuclear cells (PBMCs) in populations of varying ages. The results showed significant changes in sex steroid metabolism by human PBMCs with aging, which may represent a link to age-associated changes in the immune system (Hammer F et al 2005).

The immunomodulatory effects of DHEA in various autoimmune diseases have been studied. Relative reductions in DHEA have been noted in patients with rheumatoid arthritis, systemic lupus erythematosus, HIV and AIDS, sepsis, and trauma (Chen CC et al 2004).

Overall, DHEA blood levels have been used as diagnostic factors in evaluating immune senescence. Supplemental DHEA has been clinically valuable when used to restore youthful hormonal blood levels in aging, stressed, and immune-compromised individuals (Valenti G 2004).

One of DHEA's metabolites, 7-keto DHEA, has also been studied for its ability to support the immune system. A study at the Minnesota Applied Research Center and the Geriatric Research Education and Clinical Center in Minneapolis found that four weeks of 7-keto DHEA supplementation improved immune function in elderly men and women (Zenk JL 2004).

In this randomized, double-blind, placebo-controlled study, 22 women and 20 men over the age of 65 took either 100 mg of 7-keto twice daily or a placebo. Patients in the 7-keto group had a significant decrease in immune suppressor cells and a significant increase in immune helper cells. The 7-keto group also saw reductions in diastolic blood pressure and an increase in neutrophils, the first white blood cells to respond to infection.

POLYUNSATURATED FATTY ACIDS

Polyunsaturated fatty acids, such as the omega-3 fatty acids found in fish oil and flaxseed oil, have been studied for their anti-inflammatory action (Kaminogawa S et al 2004). Polyunsaturated fatty acid reduces the inflammatory response caused by TNF-alpha (Johnson J et al 1993; Pedersen BK et al 2000), discussed above.

Most people in the United States have an imbalance in the ratio of omega-3 fatty acids to omega-6 fatty acids because of diets high in animal fat and vegetable oils high in omega-6 (e.g., corn oil). This imbalance has been associated with inflammation (Calder PC 1997). The ratio can be improved by taking supplemental omega-3 fatty acids. Omega-3 fatty acids have also been shown to

- Counteract suppression of the cellular immune system (Pedersen BK et al 2000)
- Suppress TNF-alpha production and have an anti-inflammatory effect (Grimble RF et al 2002)

PROBIOTICS

The gastrointestinal tract relies on live bacteria (microflora) to help support a robust immune response. These probiotic bacteria are important because they help prevent foreign bacteria and allergens from passing through the intestinal wall and are important to the overall health of the intestinal immune system (Marteau P et al 2001; Conway PL et al 1987; Robins-Brown R et al 1981). Probiotics are found in foods such as yogurt and kefir, which enhance the microflora in the gut by providing additional probiotic bacteria (Fuller R 1991; Isolauri E et al 2001). The most commonly used probiotic bacteria are lactobacillus and bifidobacterium, found in yogurts.

Probiotics also strengthen the intestinal immunological barrier. Lactobacillus stimulates natural immunity by improving phagocytic

and natural killer immune cell activity (Kaminogawa S et al 2004).

GRAPE SEED EXTRACT

Chemicals in grape seeds known as proanthocyanidins have potent antioxidant and immune-boosting properties (Ashraf-Khorassani M et al 2004; Bagchi D et al 1997; Bagchi D et al 1998). They increase the activity of internal antioxidants such as glutathione and SOD (Peng Q et al 2000).

The antioxidants in grape seed extract are twice as potent as vitamin E and four times as potent as vitamin C (Bagchi D et al 1997; Bagchi D et al 1998). In laboratory studies, proanthocyanidins increased the power of natural killer cells, enhanced the production of IL-2, and decreased production of IL-6 (Cheshier JE et al 1996).

GREEN TEA EXTRACT

Green tea extract, which contains a class of compounds known as catechins, has become increasingly popular as scientists learn more about its antioxidant and free radical-scavenging abilities. One of the most potent catechins in green tea is epigallocatechin-3-gallate (Chen A et al 2002). Green tea extract is also rich in vitamins C and B (Hasegawa N et al 2002; Hasegawa R et al 1998).

Green tea has a positive influence on lipid metabolism and exerts anticancer effects. Green tea modulates the inflammatory processes and protects against DNA damage (Lin AM et al 1998). The catechins from green tea demonstrate considerable antioxidant activity (Chen A et al 2002) and are potent free radical scavengers (Zhong Z et al 2003; Jimenez-Lopez JM et al 2004).

LIFE EXTENSION FOUNDATION RECOMMENDATIONS

The nutritional recommendations discussed in this chapter, coupled with a healthy lifestyle, may improve the function of the immune system by increasing antioxidant levels in the body and minimizing free radical damage.

Some of the recommendations in the following list are based on special products created by Life Extension to address multiple conditions. In some cases, individually listed ingredients are also present in the recommended Life Extension Products. If you have questions, call 1-800-544-4440 to speak with a knowledgeable health advisor.

The following supplements may protect and enhance immune function:

- **Life Extension Mix**—as directed on label
- **Enhanced Life Extension Whey Protein**—20 to 30 g daily
- **DHEA**—A beginning dose of 15 to 75 mg, followed by blood testing after three to six weeks to guarantee optimal levels
- **L-Carnitine**—1 to 2 g daily
- **CoQ10**—100 to 200 mg daily with food
- **Lactoferrin**—1 to 3 capsules daily
- **Primal Defense Probiotic** blend—900 mg in 3 divided doses daily; best taken with water on an empty stomach
- **Omega-3 fatty acids** (fish oil)—700 mg EPA and 500 mg DHA
- **Selenium**—200 mcg daily
- **Thymic Immune Factors**—2 capsules daily
- **Zinc**—30 mg daily
- **Garlic extract**—1200 mg daily with food
- **Grape seed extract**—100 to 200 mg daily
- **Green tea extract**—725 mg daily
- **Glutathione**—1000 mg daily
- **NAC**—600 to 1800 mg daily
- **R-lipoic acid**—200 mg twice a day

IMMUNE SYSTEM SAFETY CAVEATS

An aggressive program of dietary supplementation should not be launched without the supervision of a qualified physician. Several of the nutrients suggested in this protocol may have adverse effects. These include:

Coenzyme Q10

- See your doctor and monitor your blood glucose level frequently if you take CoQ10 and have diabetes. Several clinical reports suggest that taking CoQ10 may improve glycemic control and the function of beta cells in people who have type 2 diabetes.
- Statin drugs (such as lovastatin, simvastatin, and pravastatin) are known to decrease CoQ10 levels.

DHEA

- Do not take DHEA if you could be pregnant, are breastfeeding, or could have prostate, breast, uterine, or ovarian cancer.
- DHEA can cause androgenic effects in woman such as acne, deepening of the voice, facial hair growth and hair loss.

EPA/DHA

- Consult your doctor before taking EPA/DHA if you take warfarin (Coumadin). Taking EPA/DHA with warfarin may increase the risk of bleeding.
- Discontinue using EPA/DHA 2 weeks before any surgical procedure.

Garlic

- Garlic has blood-thinning, anticlotting properties.
- Discontinue using garlic before any surgical procedure.
- Garlic can cause headache, muscle pain, fatigue, vertigo, watery eyes, asthma, and gastrointestinal symptoms such as nausea and diarrhea.
- Ingesting large amounts of garlic can cause bad breath and body odor.

Green Tea

- Consult your doctor before taking green tea extract if you take aspirin or warfarin (Coumadin). Taking green tea extract and aspirin or warfarin can increase the risk of bleeding.
- Discontinue using green tea extract 2 weeks before any surgical procedure. Green tea extract may decrease platelet aggregation.
- Green tea extract contains caffeine, which may produce a variety of symptoms including restlessness, nausea, headache, muscle tension, sleep disturbances, and rapid heartbeat.

L-Carnitine

- L-carnitine can cause gastrointestinal symptoms such as nausea and diarrhea.

Lipoic Acid

- Consult your doctor before taking lipoic acid if you have diabetes and glucose intolerance. Monitor your blood glucose level frequently. Lipoic acid may lower blood glucose levels.

NAC

- NAC clearance is reduced in people who have chronic liver disease.
- Do not take NAC if you have a history of kidney stones (particularly cystine stones).
- NAC can produce a false-positive result in the nitroprusside test for ketone bodies used to detect diabetes.
- Consult your doctor before taking NAC if you have a history of peptic ulcer disease. Mucolytic agents may disrupt the gastric mucosal barrier.
- NAC can cause headache (especially when used along with nitrates) and gastrointestinal symptoms such as nausea and diarrhea.

Selenium

- High doses of selenium (1000 micrograms or more daily) for prolonged periods may cause adverse reactions.
- High doses of selenium taken for prolonged periods may cause chronic selenium poisoning. Symptoms include loss of hair and nails or brittle hair and nails.
- Selenium can cause rash, breath that smells like garlic, fatigue, irritability, and nausea and vomiting.

Zinc

- High doses of zinc (above 30 milligrams daily) can cause adverse reactions.
- Zinc can cause a metallic taste, headache, drowsiness, and gastrointestinal symptoms such as nausea and diarrhea.
- High doses of zinc can lead to copper deficiency and hypochromic microcytic anemia secondary to zinc-induced copper deficiency.
- High doses of zinc may suppress the immune system.

For more information see the Safety Appendix

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