infoaging guides

BIOLOGY OF AGING



OXIDATIVE DAMAGE

An introduction to aging science brought to you by the American Federation for Aging Research



american federation for aging research Oxidative damage to cells can make a profound impact on critical aspects of the aging process.

WHAT IS OXIDATIVE DAMAGE?

Reactive oxygen species (ROS) are small, oxygen-containing molecules produced as byproducts when the body turns food into energy. Like rust on iron, they react with and damage cells' fats, proteins, and DNA in a process called oxidation. You can see oxidation at work in the browning of an apple's pulp when exposed to air. ROS can interfere with cells' healthy function and reproduction, and are implicated in the development of a variety of age-associated diseases and conditions including heart disease, cancer, and Alzheimer's disease.

Some oxidative damage is an inevitable consequence of the biological processes that keep us alive, but environmental factors can significantly worsen the harm. For example, researchers have found that cigarette smoking, excessive alcohol consumption, and exposure to some toxins such as mercury can raise ROS production and thereby exacerbate oxidative damage. Heavy exercise, which increases the need for oxygen, also increases ROS production, but at the same time it enhances the oxidative defenses that the body's tissues can mount, as well.

THE ROLE OF OXIDATIVE DAMAGE IN AGING

Oxidative damage occurs in every cell in our body. While our cells have natural defenses against oxidative damage, they are not 100 percent effective. As a result, injuries to cell membranes, genetic material (DNA), and proteins increase as we grow older. These injuries can make a profound impact on critical aspects of the aging process and contribute to impaired physiological function, increased incidence of disease, and a foreshortened lifespan.

OXIDATIVE DAMAGE AND AGE-ASSOCIATED DISEASES

ROS may play a critical role in the development of a host of diseases associated with aging. These include:

• **Cancer**. ROS are believed to play a role in many cancers because of the damage they do to DNA.

- Heart disease. Research has demonstrated that the circulation of oxidized LDL (sometimes called "bad" cholesterol) promotes atherosclerosis, or hardening of the arteries.
- **Diabetes**. Among the complications of longstanding diabetes are heart disease, hardening of the arteries, kidney disease, and decreased circulation to the legs. Research has linked those complications with high levels of ROS.
- Alzheimer's disease. In Alzheimer's disease, a protein called beta amyloid is belived to play a central role in the development of the illness. Beta amyloid has proven to increase ROS. Scientists originally theorized that the formation of beta-amyloid plagues in the brain accelerates oxidative damage there. However, current research has provided evidence that oxidative damage precedes the formation of beta-amyloid plaques and may contribute to it.

Parkinson's disease.

Parkinson's disease occurs when damage to certain parts of the brain produces tremors and other complications. Oxidative damage appears to play a role in the onset of Parkinson's disease. Closely allied with oxidation is nitration, the addition of nitrogen to proteins and other intracellular substances. Protein nitration may be another factor in the nerve cell damage that leads to Parkinson's.

Deafness. Deafness due to excessive noise is a phenomenon that has been recognized for centuries, but only in recent years has medical science come to understand the mechanism by which such deafness occurs. Excessive noise induces *lipid peroxidation*, a particular form of oxidative damage that produces damage to the delicate structures of the ear.

•

Macular degeneration. Ageassociated macular degeneration, a form of eye damage, is the leading cause of blindness in Americans aged 65+. Some researchers have suggested that when the retina of the eye absorbs light, excessive levels of ROS are produced, leading to oxidative damage, and, eventually, blindness.

POPULAR ANTIOXIDANTS

There are thousands of antioxidants—too many to cover here but below are some of the more popular ones. Again, although many claims are made for these substances, most of the research on them has been inconclusive at least when they're taken in supplement form. However,

observational studies suggest that eating a diet high in antioxidantrich vegetables and fruits is associated with a lower risk for many chronic diseases. That may be because supplements provide concentrated doses of single chemicals or simple formulations, while foods contain broad arrays of biologically active chemicals that work together to produce positive health effects. Please keep in mind that none of the following antioxidants have, to date, indisputably proven their ability to live up to the claims made for them when they're taken in supplement form.

- Vitamins C and E. Some supplement enthusiasts have claimed that vitamins C and E, through antioxidant activity, can variously reduce the risk of fatal and non-fatal heart attacks, strokes, dementia, cancer, and deterioration of the immune system. Research continues, but so far, has been unable to support these claims unequivocally. Sources of vitamin C include broccoli, bell peppers, parsley, Brussels sprouts, cauliflower, citrus fruits, and strawberries. Natural sources of vitamin E include nuts, seeds, and vegetable oils.
- Carotenoids. Carotenoids are naturally occurring pigments that give fruits and vegetables their bright colors. There are dozens of carotenoids, and most of them are thought to have antioxidant properties. Some of the best studied and best understood carotenoids are lycopene, found in tomatoes; lutein and zeaxanthine, found in corn, orange peppers, kiwi, and various kinds of squash; and beta-carotene. found in orange, yellow, and deep green vegetables. Carotenoids may

help prevent cardiovascular problems and cancer.

- Selenium. Selenium is a trace mineral that is essential to good health. Proteins incorporate it to make selenoproteins, which are important antioxidants that help prevent oxidative damage to cells. Some older people whose diets are deficient in substances such as zinc, vitamin B6, and selenium have developed weakened immune systems. Selenium may have a role in preventing cancer, particularly cancer of the breast, as well as heart disease and rheumatoid arthritis. Sources include Brazil nuts, tuna, cod, and turkey. Eat Brazil nuts only occasionally, as they can contain very high concentrations of selenium, and you only need trace amounts to maintain good health. Too much selenium can cause liver damage, gastrointestinal upset, and problems with your endocrine (hormonal) system.
- Coenzyme Q10. Coenzyme Q10 is an antioxidant thought to have benefits in heart disease, but so far, research data haven't supported this hypothesis. Natural sources include oily, cold water fish such as tuna, salmon, mackerel, halibut, sardines, and herring.
- **BHT and BHA.** BHA (butylated hydroxyanisole) and BHT (butylated hydroxytoluene) are synthetic antioxidants as added to many packaged foods as preservatives. Studies are underway to determine whether substances have any health benefits, particularly in cancer prevention.

- Melatonin. Melatonin is a substance secreted by the pineal glands in our brains. Because melatonin is known to have antioxidant properties, studies have begun to see if melatonin supplements can reduce the risk of certain diseases.
- Flavonoids. Flavonoids are pigments that give many fruits and vegetables their characteristic color. The flavonoids found in green tea (and also in black tea) have been observed to have antioxidant effects in laboratory studies, but results in human studies have been mixed.

THE FUTURE OF OXIDATIVE DAMAGE RESEARCH

Despite over four decades of study, our understanding of oxidative damage and the role of antioxidants in health is still in its infancy. Much of the research done to date has produced contradictory results. Some antioxidants that looked good in the lab, for example, have proven less effective or even dangerous in people. This seems particularly true for antioxidants taken in supplement form.

Beta carotene, a substance found in deep orange, yellow, and green vegetables, is a case in point.



While people who both smoke and have a high beta carotene dietary intake seem to lower their risk for lung cancer, people who take the substance in supplement form over a long period of time actually increase their risk. Future research will likely clarify the benefits and dangers of various antioxidants.

Research may also cause us to radically rethink our diets. If much of aging is due to increased oxidative damage to our cells and food is our best source of antioxidants, nutritionists could potentially design age-defying diets that would provide the best combinations of antioxidants to ward off disease. Less radically, research will probably continue to confirm what our mothers have told us all along: "If you want to be healthy and strong (and we might add, long-lived), eat your fruits and vegetables."

Other research will likely seek to ascertain the effect of genes on antioxidant levels in the body. If we can understand this relationship, we may someday be able to escape or at least delay the onset of inherited diseases by ingesting the right combination of antioxidants. We may even forestall the onset of age-associated vision, hearing, and memory loss and perhaps significantly confront other age-associated physiological maladies.

American Federation for Aging Research (AFAR) 55 West 39th Street, 16th Floor New York, NY 10018

Phone: (212) 703-9977 Toll-free: (888) 582-2327 Fax: (212) 997-0330 Email: info@afar.org Websites: www.afar.org www.afar.org/infoaging

Facebook and Twitter: AFARorg