# SUPEROXIDE DISMUTASE (SOD)

## SUPEROXIDE DISMUTASE (SOD) IN THE HUMAN BODY

Superoxide dismutase or SOD is one of four intrinsic enzymatic antioxidants that have evolved naturally to lessen damage from free radicals. In addition to superoxide dismutase (SOD), the other molecules in this group of enzymatic antioxidants are catalase (CAT), glutathione peroxidase (GPx), and glutathione reductase (GR). This group of antioxidants is unique from other antioxidants that are classed as non-enzymatic.

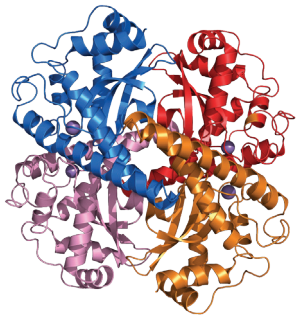
The production of free radicals occurs as a consequence of breathing air and using oxygen to burn cellular fuel for energy production. During this process, more free radicals are created than are used for tissue energy requirements. These extra radical molecules damage surrounding tissue and cause gradual physiologic decline over many years, resulting in visible aging. In addition to the metabolic origin of free radicals, skin experiences huge amounts of oxidative stress via solar exposure. Topical and/or ingested dietary antioxidants may assist in protection from free radical damage. To also assist with the neutralization of reactive oxygen species within cells, biologic systems have developed an enzymatic antioxidant system consisting of the four molecules listed above – SOD, CAT, GPx and GR.

The term "enzymatic" antioxidant refers to the fact that SOD, CAT, GPx and GR are enzymes. Since they are enzymes, these molecules are not consumed in chemical reactions. Even though they are required for the neutralization of reactive oxygen species (ROS) in specific chemical reactions, they themselves are not used up in the process. Thus, even after a chemical reaction involving one of them occurs, the antioxidant remains intact and is able to again participate in a free radical neutralization reaction. In contrast, the "non-enzymatic" antioxidants such as vitamin C are consumed while acting as antioxidants. Only tiny amounts of the four enzymatic antioxidants are required in these reactions compared to the larger amounts of non-enzymatic antioxidants required to absorb ROS.

## THE IMPORTANCE OF SOD IN AGING

Studies with Drosophila melanogaster (fruit flies) have shown that increasing SOD levels can improve aging. When the genetic characteristics of fruit flies were manipulated to increase SOD expresion, the flies showed a mean lifespan increase of up to 40%.

*The SOD molecule*



Caloric restriction is a technique verified to cause average lifespan increases in many organisms, including rodents, yeasts, fruit flies, worms and primates. With caloric restriction/energy restriction (ER), calories are decreased by 30% to 50% while maintaining nutrient density. Caloric restriction is also strongly suggested to increase average human lifespan, although, due to the long human lifespan, studies have not been conducted for an extensive enough time frame. Animal groups with caloric restriction have greater gene expression of SOD than other groups of organisms. Mean lifespan has been increased 16% with caloric restriction/energy restriction.

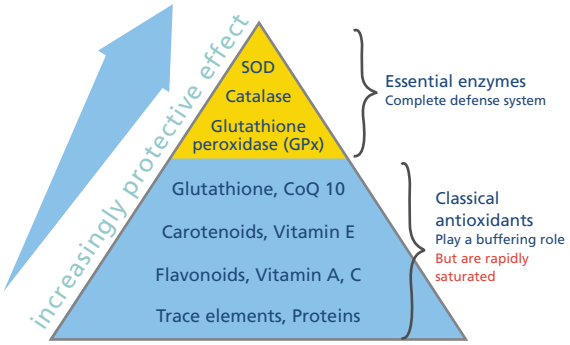
Eating a healthy diet also improves parameters of oxidative stress and can improve health span. For example, apples contain large amounts of polyphenols, known to neutralize free radicals. Supplementing the diet with apple polyphenols increases the lifespan of fruit flies by 10% via upregulating the genes coding for enzymatic antioxidants like superoxide dismutase – including SOD1, SOD2, and CAT. Blueberry extract, soybean isoflavones, and black rice anthocyanins have also been studied and shown similar effects. Scientific evaluations show that many natural antioxidants and functional foods like apple, blueberry, soybean, green tea, black tea, and black rice possess high antioxidant activity, upregulate SOD genes, increase the amount of SOD produced by the organism, and could play an important role in delaying aging.

## USING SUPEROXIDE DISMUTASE (SOD) IN COSMECEUTICALS

Previously, superoxide dismutase (SOD) could only be injected IV (intravenously) because absorption was not possible orally or topically. Then SOD became available in an oral form that could be absorbed

through the gastrointestinal tract if specially combined with particular proteins. Superoxide dismutase can now be incorporated into cosmeceuticals and is available in a unique topical form which can be absorbed through the skin.

Studies on the topical form of superoxide dismutase used in INNOVATIVE SKINCARE® products prove that it is absorbed into the skin and reduces free radical damage/oxidative stress. This SOD protects against lipid peroxidation in delicate skin cell membranes, neutralizes the superoxide radical, protects against damaging environmental conditions, guards against pollution, combats photoaging, and reduces UV-induced erythema while enhancing protective effects of sun care products. Unlike non-enzymatic antioxidants that are destroyed during redox activity, this ingredient remains active after electron donation and is able to continue on with skin defense.




*The pyramid above explains the high antioxidant protection afforded by SOD compared to other antioxidants.*

In studies using INNOVATIVE SKINCARE®'s, SOD, cell products known to be associated with free radical damage and/or protection from oxidative stress were measured in situations of oxidative stress. Improvements were shown in these parameters, including lactic dehydrogenase (LDH), malonyldialdehyde (MDA), and prostaglandin E2 (PGE2). The topical SOD used in INNOVATIVE SKINCARE® products completely prevents the formation of PGE2 in the arachidonic acid cascade. PGE2 has been implicated in all types of pro-inflammatory processes ranging from sunburn to skin cancer development. This topical SOD decreases MDA formation and protects cell membranes more effectively than the more commonly used non-enzymatic antioxidants.

It is well known that excess free radical formation is associated with solar damage, environmental stresses and aging. Furthermore, ongoing oxidative stress and its resultant inflammatory up-regulation are associated with even further downstream tissue injury. The proven reduction of inflammatory markers and oxidative parameters illustrates the benefits to the skin of this unique form of topical SOD.

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