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Editorial

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Aging: A Little (Oxidative) Stress is Good for You

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Heightened interest in the aging process by the public and scientific community has occurred due to the increase in percentage of elderly in the population and the increase in health care expenditures committed to the elderly [1]. Due to this increased interest, current research into aging demonstrates it as a complex process that is the result of interplay between naturally occurring processes, such as changes in hormonal levels and gene transcription that occur during the biological timeline of human development, and the exposure of our body's systems to environmental damage [2]. At a physiological level, aging is the functional decay overtime of cells, organs and tissues, specifically through chemical damage of the cellular components proteins, DNA and lipids. The problems of aging include issues such as declining muscle tone and mass, wrinkled skin and mutant mitochondria. What is noteworthy with studies done on laboratory animals is that it is not necessary to combat individually all the problems of aging, since through modifying a regulatory gene or signaling network is sufficient to induce longevity along with the postponement of age related diseases [3].

One of the prevalent theories regarding a causal agent for aging involves free radicals, which are molecules containing unpaired, highly reactive electrons. Harman postulated that damage to macromolecules by free radical production in aerobic organism is a major determinant of life span [4]. It was later discovered that normal aerobic metabolism naturally produces superoxide (O_2^-) and hydroxyl (OH^-) byproducts (known collectively as reactive oxygen species or ROS) that can adversely modify lipids, proteins and DNA [5]. ROS have been implicated in aging and in many age related diseases including Alzheimer's, Parkinson's and Cancer [6].

Signaling pathways become activated in cells to limit the insult from ROS by generating antioxidant proteins (e.g. Superoxide Dismutase (SOD) and Glutathione S-Transferase (GST) proteins) that remove high levels of ROS, induce cell survival or increase cell death and senescence. Levels of reduced glutathione are lower in Parkinson Disease brains indicating oxidative stress [7]. In humans, there are a number of stress-activated pathways [2], such as the nuclear factor erythroid-2-related factor 2 (Nrf2) pathway that plays a prominent role in oxidative stress response. The Nrf2 pathway induces the expression of antioxidant and cytoprotective enzymes suggesting that increasing activity of this pathway would potentially be useful for the treatment of age related diseases such as Alzheimer's and Parkinson Disease [8,9].

However, theories regarding the precise role of ROS in influencing aging are still debatable. Recent data has demonstrated that small amounts of ROS in worms increase lifespan [10,11] although large amounts may still be harmful. The increase in lifespan upon low exposure of ROS may be due to induction of stress response pathways that promote longevity when active. Although these findings do not dismiss the theory that molecular damage causes aging, they do suggest that ROS can act as a protective signal and, at the very least, demonstrate that a thorough study of stress response pathways is necessary to properly understand the aging process.

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