Oxidative Stress

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Oxidative metabolism is a mainstay of aerobic life and utilizing oxygen in biological systems is associated with the formation of reactive oxygen species (ROS). ROS are either radicals, e.g. hydroxyl radical, peroxyl radical, superoxide radical anion, or reactive non-radical compounds such as singlet oxygen, peroxynitrite or hydrogen peroxide. Their half-lives vary from a few nanoseconds for the most reactive compounds to seconds and hours for rather stable radicals. ROS react with biologically relevant molecules and modification or destruction of DNA, lipids, carbohydrates and proteins has been related to the pathogenesis of several degenerative diseases. However, ROS are also generated in defense systems of our organism. Phagocytic cells such as neutrophils or activated macrophages defend against foreign organisms by generating superoxide radical anions through NADPH oxidases and myeloperoxidases.

Balancing ROS levels and preventing oxidative damage is the task of a multilayered defense system with enzymatic and nonenzymatic antioxidants and adaptive responses. Dietary antioxidants including ascorbate, tocopherols, carotenoids, and polyphenols scavenge ROS and contribute to defense. As a part of the antioxidant network they have been suggested to protect against oxidative damage associated with an increased risk for several degenerative diseases. „Oxidative stress“ is defined as an imbalance between oxidants and antioxidants in favor of the oxidants, leading to a disruption of redox signaling and control and/or molecular damage. Depending on the pathway of generation, or the major reactive oxygen species formed, the phenomenon of oxidative stress can be subdivided. Accordingly, terms as photooxidative stress, drug-dependent oxidative stress, metabolic oxidative stress, environmental oxidative stress, or nitrosative stress have been coined. Nutritional, dietary and postprandial oxidative stress addresses oxidative challenge to nutrients, the generation of prooxidants and antioxidants from dietary components and the responses of the organism in adaptive and pathophysiological processes.

There is increasing evidence that ROS play a role in the regulation cellular signaling either by direct interaction with signaling molecules or via modulation of the cellular redox state. Cellular redox sensors trigger the expression of genes for adaptive responses and defense. In this context antioxidants from exogenous sources may also modulate cellular pathways related to redox signaling. Thus, current research approaches on oxidative stress go beyond the aspect of damage prevention or repair looking into redox-sensitive fine tuning of complex cellular processes owed to a life in an oxygen atmosphere.

Formation of reactive oxygen species and the antioxidant network of defence


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