

# Glossary

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### Peroxides

Peroxides are chemical substances that contain a peroxy unit - one that has an oxygen-oxygen bond (O–O) and the chemical formula of  $O_2^{2-}$ . The most familiar example of a peroxide is hydrogen peroxide.

### Hydroperoxides

Hydroperoxides contain the  $O-O-H$  unit. Hydrogen peroxide is therefore also an example of a hydroperoxide. Another hydroperoxide, lipid hydroperoxides, are also a marker of free radical injury. Free oxygen radicals can react with membrane lipids to form lipid hydroperoxides, a destructive process known as lipid peroxidation. Lipid peroxidation leads to oxidative injury of biologic membranes in vivo.

### Aldehydes

An aldehyde is either a functional group consisting of a terminal carbonyl group or a compound containing a terminal carbonyl group. Aldehydes such as malondialdehyde are also products of free radical injury. Lipid hydroperoxides decompose to form a variety of products including malondialdehyde, which is used as an indicator of the oxidative damage of cells and tissues.

### Catalase

Catalase is a common enzyme that functions to catalyze the decomposition of hydrogen peroxide to water and oxygen. Catalase is an important anti-oxidant enzyme that protects the cell from free radical injury.

### Glyceraldehyde-3-phosphate dehydrogenase

Glyceraldehyde-3-phosphate dehydrogenase is an enzyme in the glycolytic pathway. It is significant that this glycolytic enzyme reduces nicotinamide adenine dinucleotide (NADH). During ischemia, glyceraldehyde-3-phosphate dehydrogenase can become rate-limiting for glycolysis. It is also an enzyme that is sensitive to free radical injury.

### Glutathione peroxidase

Glutathione peroxidase is a peroxidase found in cells that helps to prevent lipid peroxidation of the cell membrane. The function of glutathione peroxidase is to reduce lipid hydroperoxides to their corresponding alcohols and to reduce free hydrogen peroxide to water.

### Adenylate cyclase

Adenylate cyclase is an enzyme that catalyzes the conversion of ATP to cAMP. cAMP is an important second messenger molecule involved in signal transduction. Adenylate cyclase is activated or inhibited by G proteins, which are coupled to membrane receptors, such as the  $\beta$ -adrenergic receptor.

### Ubiquinone

Ubiquinone (often called coenzyme Q10) is a quinone compound that serves as an electron carrier between flavoproteins. Ubiquinone is a component of the oxidative phosphorylation process in mitochondria that converts the energy from fatty acids and carbohydrates into ATP (the main source of energy used to drive cellular machinery and synthesis). An additional role of ubiquinone is that it acts in its reduced form (ubiquinol) as an antioxidant.

### Alphatocopherol

Alphatocopherol (or vitamin E) is an antioxidant that protects cell membranes from free radical-induced lipid peroxidation. Ubiquinone can recycle radical forms of vitamin E, thereby also protecting membrane phospholipids against peroxidation.

### Xanthine oxidase

Xanthine oxidase is an enzyme that catalyzes the oxidation of hypoxanthine to xanthine and can further catalyze the oxidation of xanthine to uric acid. A byproduct of the xanthine oxidase reaction is superoxide. Therefore, xanthine oxidase is an important source of cellular free radical generation.

## Uncoupling of NO synthase

Nitric oxide (NO<sup>\*</sup>) is an important protective molecule in the vasculature. Endothelial NO<sup>\*</sup> synthase (eNOS) is responsible for most of the vascular NO<sup>\*</sup> produced. The normal function of eNOS is to oxidize its substrate L-arginine to L-citrulline and NO<sup>\*</sup>. This normal function of eNOS requires dimerization of the enzyme in the presence of the substrate L-arginine. This reaction requires an essential co-factor, tetrahydro-L-biopterin (BH<sub>4</sub>), one of the most potent naturally occurring reducing agents. However, if BH<sub>4</sub> is diminished due to oxidation, eNOS can promote the production of the free radical, superoxide (O<sub>2</sub><sup>\*-</sup>). If this occurs, the process is referred to as eNOS uncoupling.

## Protein carbonyls

Free radicals can target lipids, DNA or proteins. One of the products of free radical damage to proteins is

the formation of protein carbonyls. Oxidatively modified forms of proteins accumulate during oxidative stress.

## Bradykinin

Bradykinin is a small peptide of the kinin group of proteins, consisting of nine amino acids. It is a potent endothelium-dependent vasodilator that causes contraction of non-vascular smooth muscle, increases vascular permeability and is also involved in the mechanism of pain.

## Endothelin-1

Endothelin-1 is small peptide produced in a variety of tissues including endothelial and vascular smooth-muscle cells. It acts as a modulator of vasomotor tone, cell proliferation, and hormone production. It is a potent vasoconstrictor.



