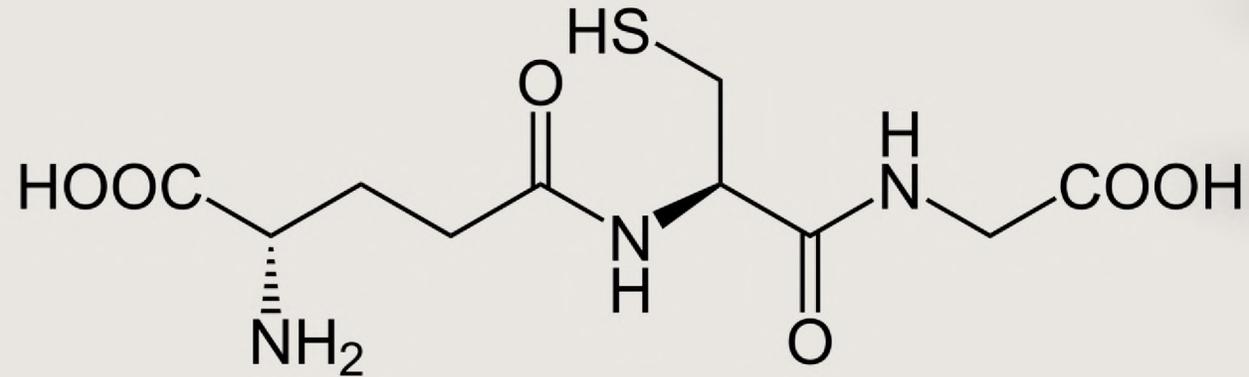


# Glutathione

Antioxidant effect and occurrence in nature.

Ravn Leonard Pater  
University of Rzeszów

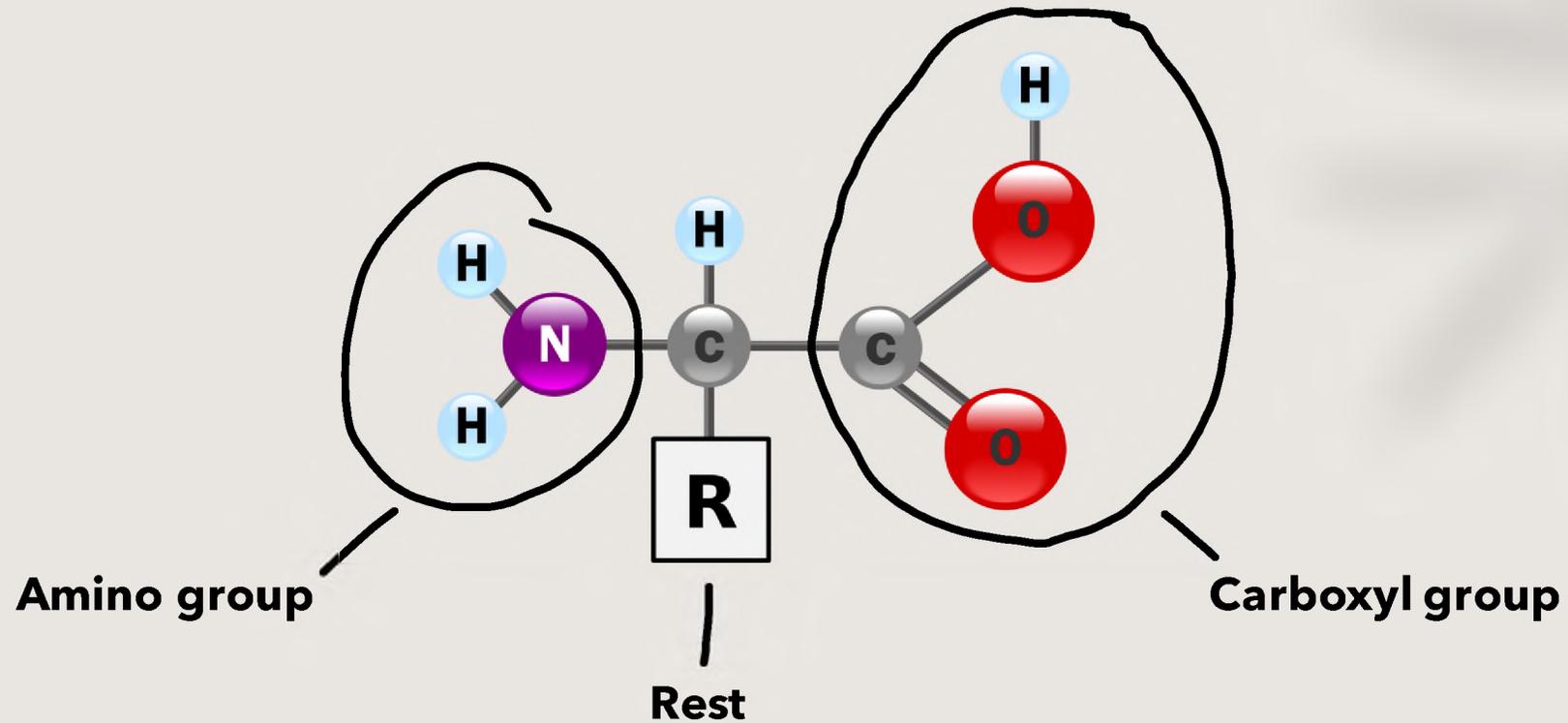
# What is Glutathione from a chemical point of view?

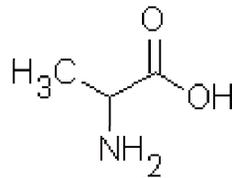


a tripeptide\* formed from the three amino acids:  
**glutamic acid**, **cysteine** and **glycine**.

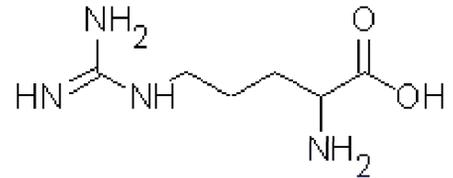
\*Glutathione is not a true tripeptide because the amide bond between glutamic acid and cysteine is formed via the  $\gamma$ -carboxy group of glutamic acid and not via the  $\alpha$ -carboxy group as in a true peptide bond.

Short reminder: The structure of an amino acid.

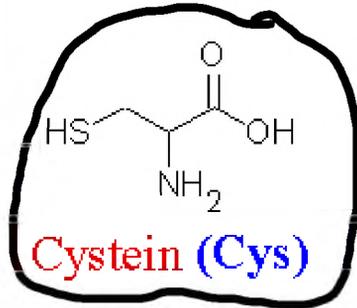




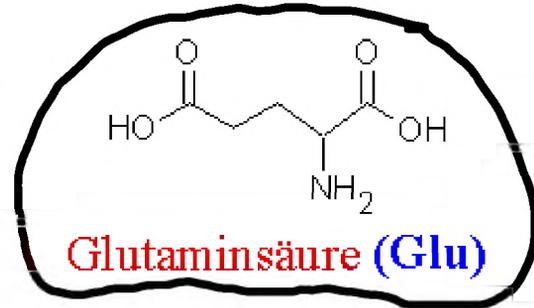
**Alanin (Ala)**



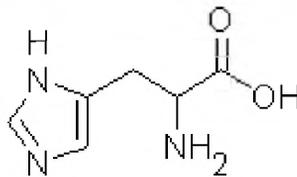
**Arginin (Arg)**



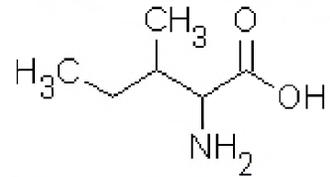
**Cystein (Cys)**



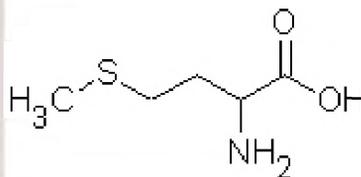
**Glutaminsäure (Glu)**



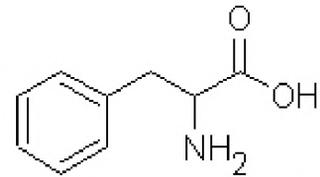
**Histidin (His)**



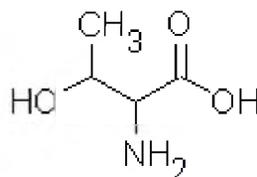
**Isoleucin (Ile)**



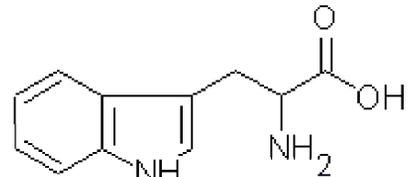
**Methionin (Met)**



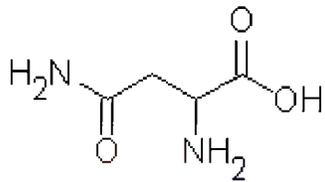
**Phenylalanin (Phe)**



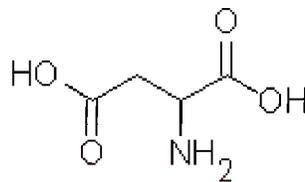
**Threonin (Thr)**



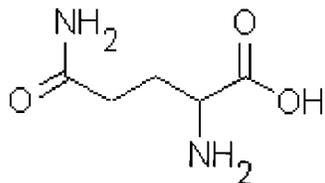
**Tryptophan (Trp)**



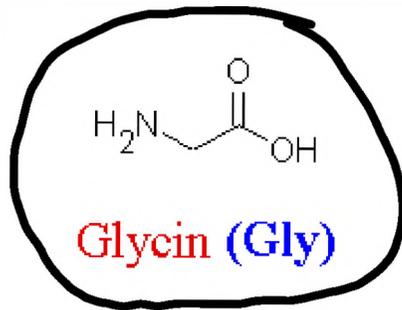
**Asparagin (Asn)**



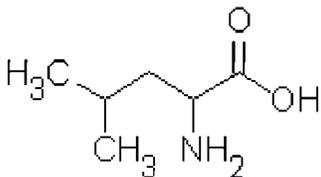
**Asparaginsäure (Asp)**



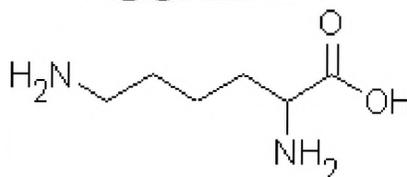
**Glutamin (Gln)**



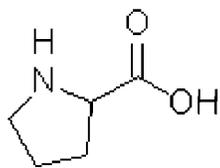
**Glycin (Gly)**



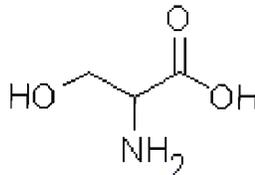
**Leucin (Leu)**



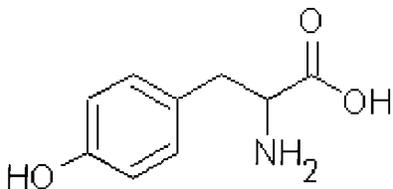
**Lysin (Lys)**



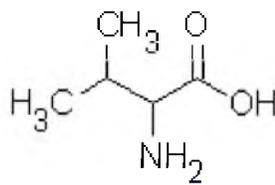
**Prolin (Pro)**



**Serin (Ser)**



**Tyrosin (Tyr)**



**Valin (Val)**

## Short reminder: What is oxidation?

Oxidation is a chemical reaction in which an atom, ion or molecule gives up electrons. Its oxidation number is increased in the process. Another substance accepts the electrons and is reduced. Both reactions together are considered as partial reactions of a redox reaction.

# What are radicals?

In chemistry, radicals are atoms or molecules with at least one unpaired valence electron. Most radicals are particularly **reactive**. Radicals are represented by a "dot" symbolizing the unpaired electron, for example nitric oxide (NO•).

# ROS

Reactive oxygen species (ROS) - also simplified as "oxygen radicals" - are oxygen-containing molecules.

In the organism, reactive oxygen species are produced **in the mitochondria as a by-product of cellular respiration** (by monoaminoxidases and as part of the respiratory chain at complex I and at complex III), but also by inflammatory cells, thus damaging viruses and bacteria.

Environmental toxins and cigarette smoke are other significant sources of reactive oxygen species.

Oxidative stress is a metabolic condition in which a quantity of reactive oxygen species (ROS) is formed or present that exceeds physiological levels.

## OXIDATIVE STRESS



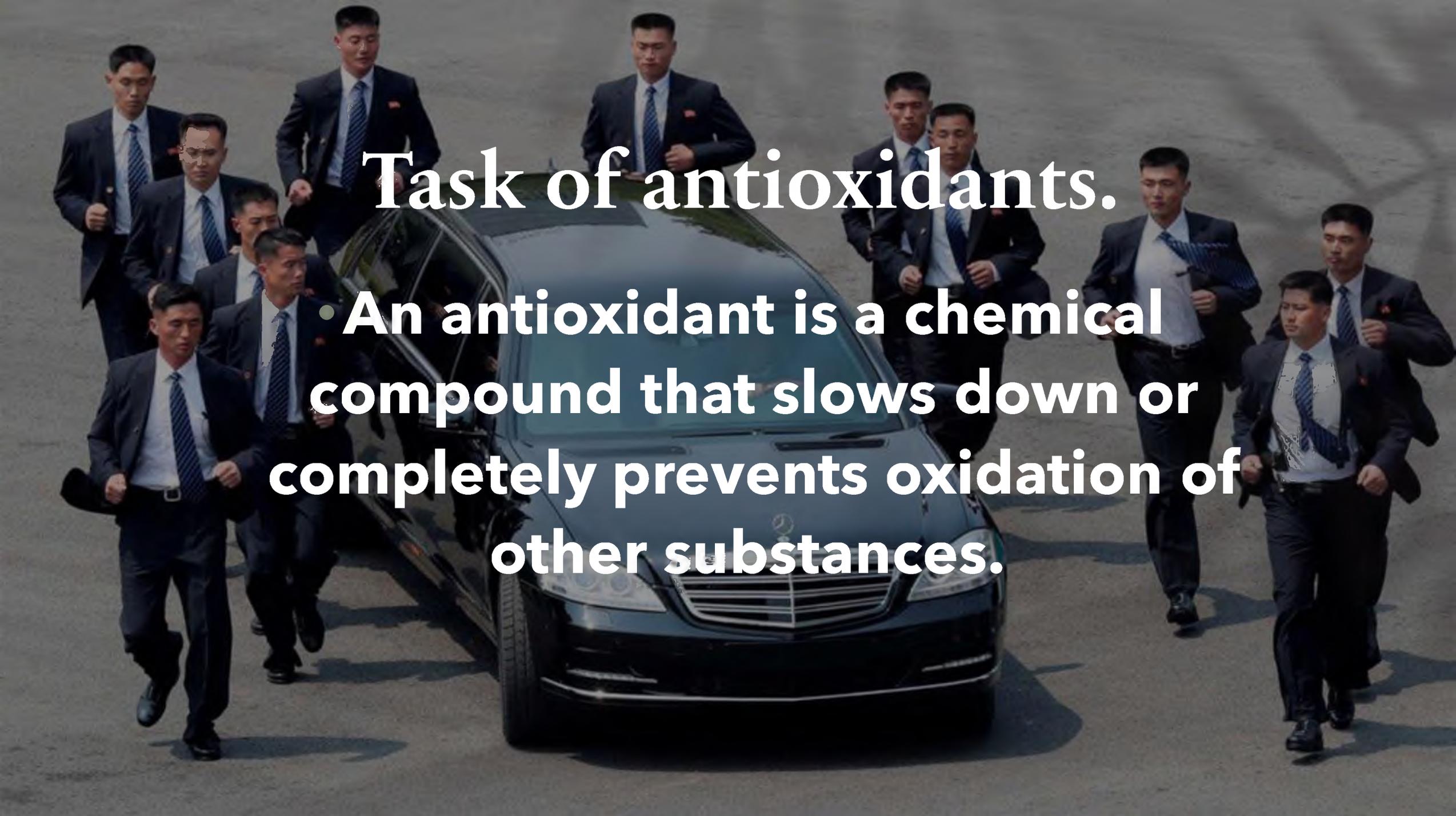
Normal Cell



Free Radicals  
Attacking Cell



Cell with  
Oxidative Stress

A group of approximately 15 men in dark suits and ties are running around a black Mercedes-Benz sedan. They are running in a circular pattern around the car, which is parked on a paved surface. The men are looking forward with serious expressions, suggesting a sense of urgency or a race. The car is a modern sedan with a prominent grille and headlights. The background is a plain, light-colored surface, possibly a parking lot or a road. The overall scene conveys a sense of speed and competition.

# Task of antioxidants.

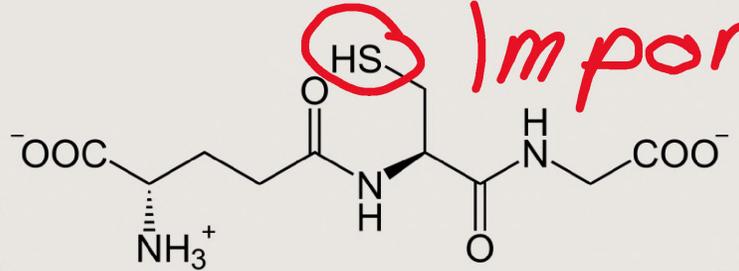
- **An antioxidant is a chemical compound that slows down or completely prevents oxidation of other substances.**

# Glutathione is a reducing agent:

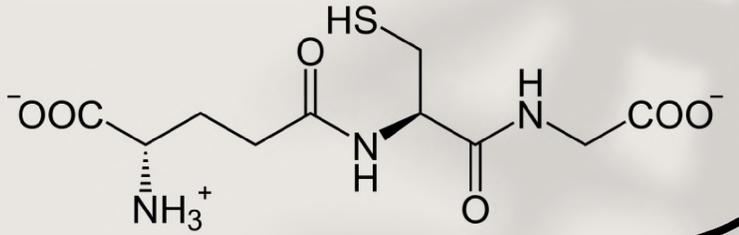
Reducing agents have a very low redox potential - their protective effect comes from the fact that they are oxidized sooner than the substance to be protected. They are predominantly effective in hydrophilic matrices.

\* There are also radical scavengers, which are more effective in lipophilic environments, and then there are antioxidant synergists. But glutathione does not belong to these, so it will not be discussed further here.

**Important**

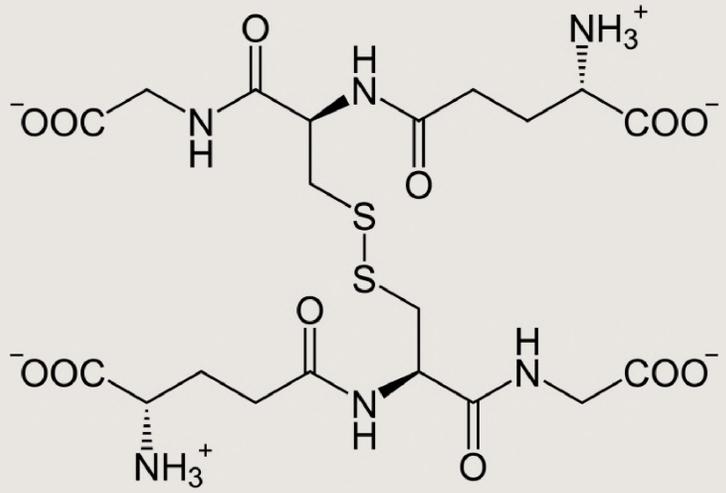


2x glutathione (reduced, GSH)

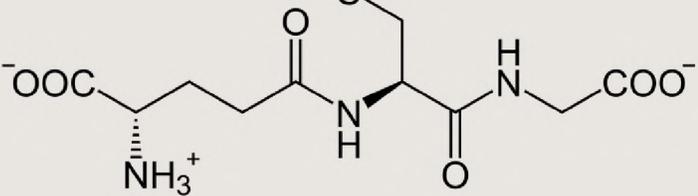
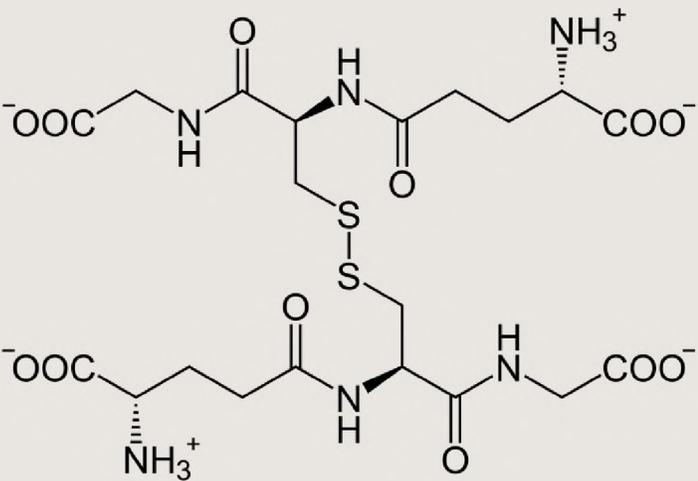


$H_2O_2$  or Protein-Disulfid  
 $2 H_2O$  or Protein-Dithiol

Glutathione peroxidase  
or Protein disulfide  
reductase (glutathione)



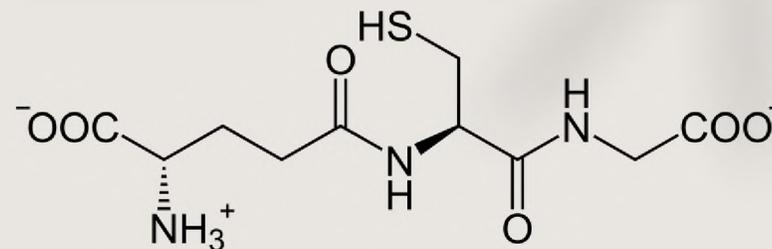
Oxidized glutathione  
(glutathione disulfide,  
GSSG)



**NADPH/H<sup>+</sup>**

**NADP<sup>+</sup>**

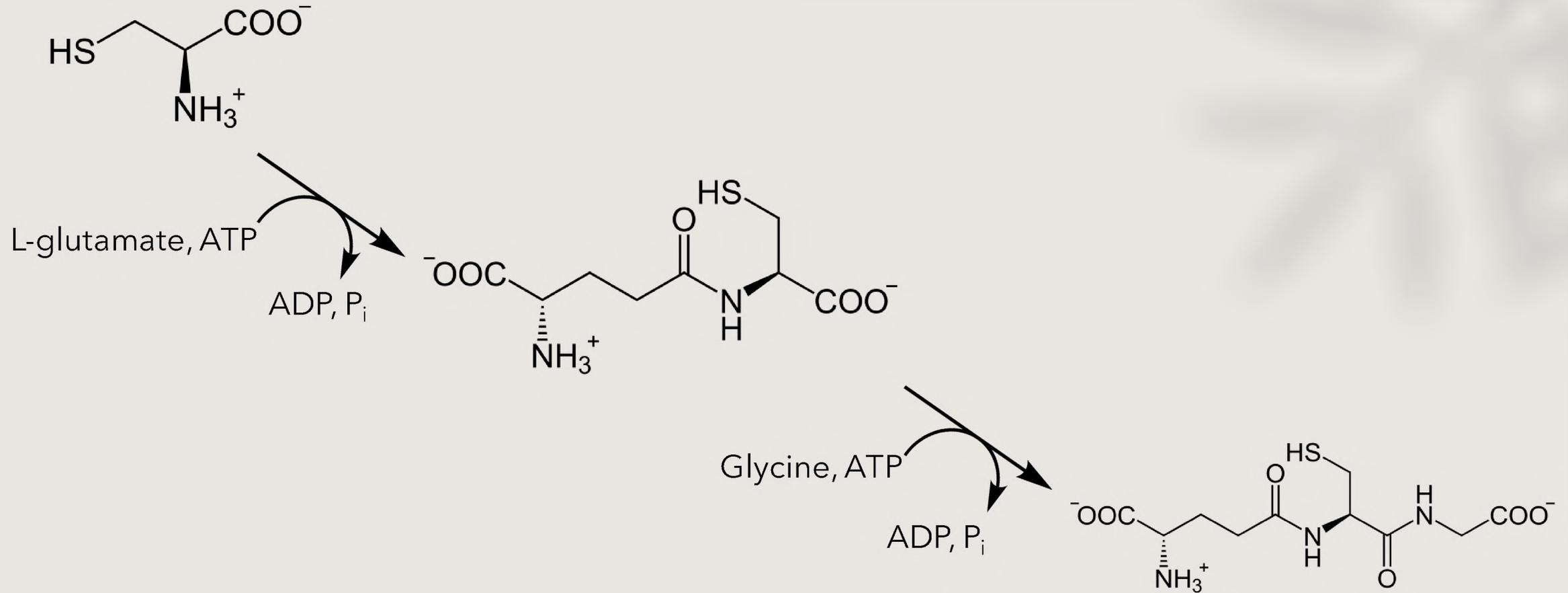
Glutathione disulfide reductase



Due to its antioxidant effect, glutathione is sold as a dietary supplement. The bioavailability of dietary glutathione is generally considered to be very low, but was investigated in April 2013 by a Penn State College study of 54 undergraduates with positive results.

**Parenteral** delivery increases GSH levels in cells.

Since bioavailability is poor, there would be another idea: one could ingest a precursor. For example, cysteine ... Or acetylcysteine ACC



Conclusion: since the bioavailability of glutathione is very poor, it does not make sense according to current knowledge to supplement it via nutrition. Even the targeted increase through the precursors are not undoubtedly low risk.

Antioxidants have a great physiological importance due to their action as radical scavengers. They inactivate reactive oxygen species (ROS) in the organism, the excessive presence of which leads to oxidative stress, which is associated with aging and the development of a number of diseases. Low, i.e. physiological, amounts of ROS, on the other hand, are quite necessary as signaling molecules that increase the stress resistance capacity, health and life expectancy of model organisms and humans. A dietary intake (supplementation) of antioxidants can therefore lead to an increased incidence of cancer and an increased risk of death in humans, according to certain studies.