

# Nutrients

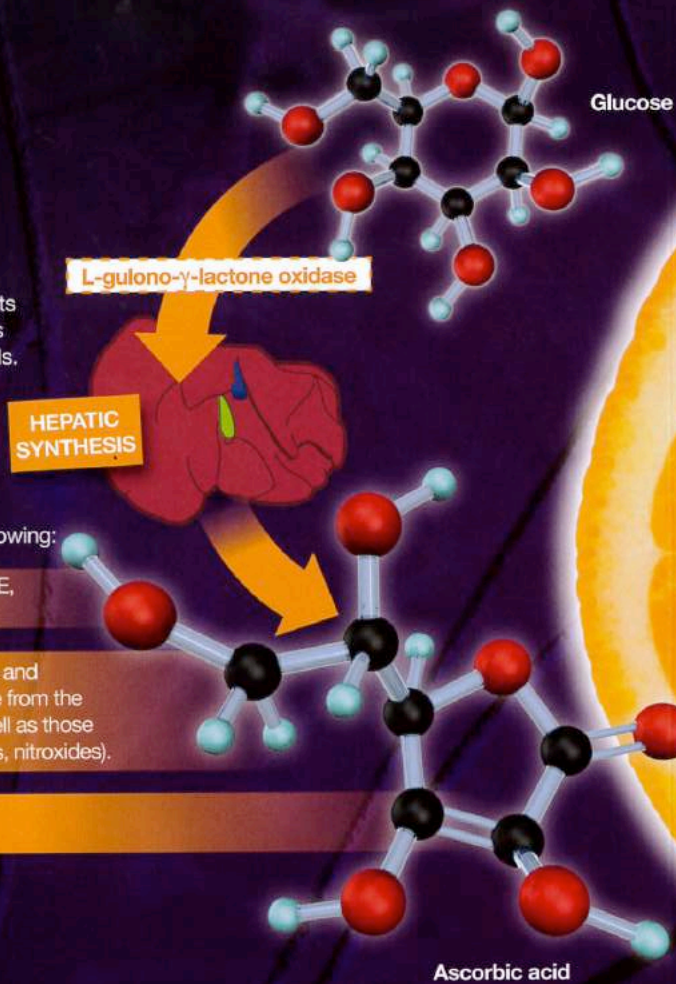
## Antioxidants: Vitamins C and E

### Vitamin C (ascorbic acid)

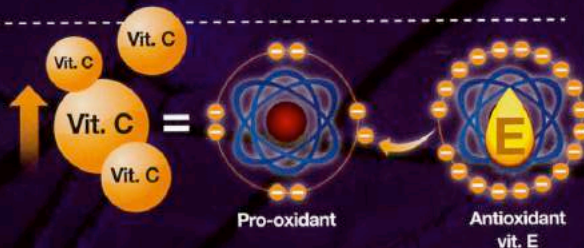
Vitamin C, or ascorbic acid, is not essential in pets given that it is synthesized in the liver from the metabolism of glucose and with the intervention of L-gulono- $\gamma$ -lactone oxidase, although the capacity of cats and dogs to synthesize this vitamin is only a fourth of that of other mammals.

Some of its functions include the following:

- ✓ Regeneration of oxidized vitamin E, glutathione and flavonoids.
- ✓ **Redox factor:** captures the intra- and extracellular ROS, including those from the metabolism of cancer cells, as well as those derived from the  $N_2$  (peroxynitrites, nitroxides).
- ✓ Maintains transition metals in their reduced form.



The ingestion of high levels acts like a pro-oxidant, which facilitates the oxidation of the membrane lipids. In this case, the ingestion of vitamin E should be increased.



Vit. C recommended	mg/1,000 kcal ME
Adults	25-50
Seniors	
Suspicious of CDS	37.5

Due to its effect on the urinary pH, this should be evaluated in senior cats when the recommended levels of vitamin C are surpassed.



Vit. C (mg/day)

1,000

pH  
from 6.9  
to 6.5

Diarrhea

# to fight CDS (I)



## Vitamin E

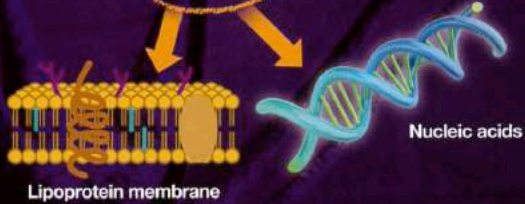
This is the generic name for tocols and tocotrienols.  $\alpha$ -tocopherol is the isomere with the greatest biological activity, although it has not been tested in dogs and cats.

Its absorption and metabolism is linked to that of fats. Any factor that affects pancreatic or biliary secretion will alter the efficiency of the intestinal use of vitamin E.

It is the greatest fat-soluble antioxidant present in plasma, erythrocytes and tissues.



Vitamin E acts as a donor of hydrogen from the 6-OH group in the presence of free radicals, especially peroxide radicals. It prevents oxidative damage to the nucleic acids and to the poly-unsaturated FAs of the lipoprotein membranes.



It has low toxicity, but high levels interfere in the metabolism of vitamins D and K. Its safe upper limit is between 13-20 times higher than its recommendations.



Vit. E recommended	mg/1,000 kcal ME
Adults	120-125
Seniors	120-125
Suspicious of CDS	120-125 x 2
Benefits to the immune system	140                      500

In general, the levels of inclusion surpass the recommendations by more than 10 times, possibly due to the differences in the biological potency of the different isomeres and due to the losses associated with manufacturing.

Its use should always be in association with other antioxidant substances, such as vitamin C, given that on certain occasions it temporarily turns into radical  $\alpha$ -tocopherol, with pro-oxidant activity.



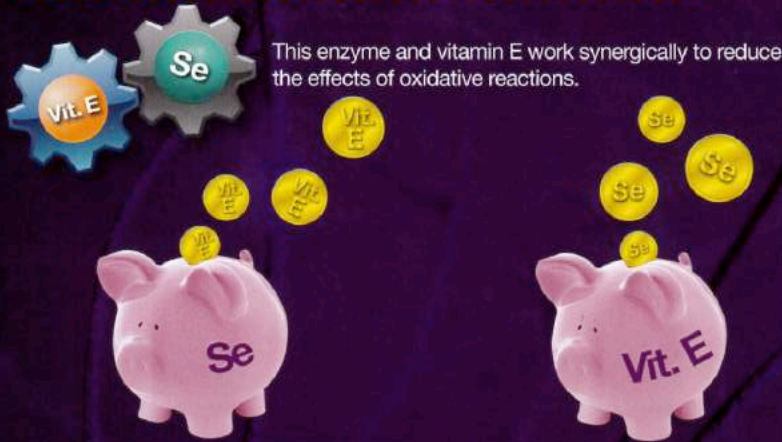
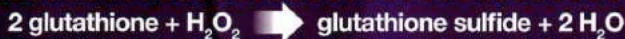
# Nutrients to

## Other antioxidants

1

### Selenium

This micromineral forms part of the **glutathione-peroxidase** and its deiodinase and reductase isoforms. Unlike vitamin E (a membrane antioxidant), this enzyme is a powerful intracytoplasmatic antioxidant, representing the second line of defense when faced with peroxidation. The reaction would be as follows:



This enzyme and vitamin E work synergistically to reduce the effects of oxidative reactions.

Selenium is a vitamin E saver for various reasons:

- ✓ It maintains the integrity of the pancreas, which is needed to digest fats.
- ✓ It reduces the vitamin E requirements via glutathione-peroxidase.
- ✓ It retains vitamin E in plasma.

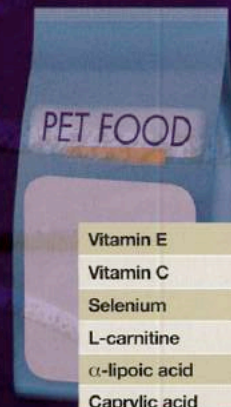
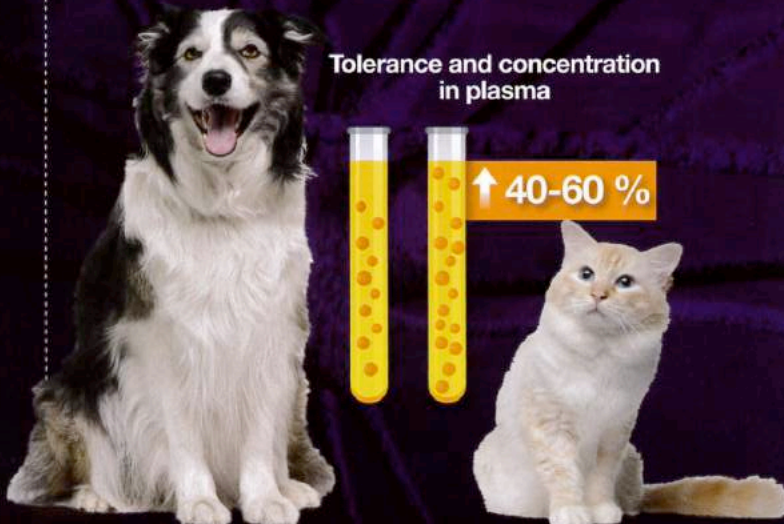
Vitamin E itself reduces the selenium requirements in two ways:

- ✓ It maintains and avoids losses.
- ✓ It prevents the destruction of the membrane lipids (and the formation of ROS), therefore decreasing the requirements of the selenium-dependent enzyme.

There is no available data regarding the recommendations for this mineral in adult cats and dogs; it is considered that the recommendations for puppies and kittens ensure adequate ingestion of selenium. The recommendations for treating CDS are the same as the dose present in foods for healthy adult and senior animals (see table). Although it does not exist as such, the safe upper limit is established at 0.5 mg/1,000 kcal ME.

It seems that cats are more tolerant than dogs and other species to this micromineral; its concentration in plasma is 40-60 % higher. The nature of this effect is unknown.

### Tolerance and concentration in plasma



	CDS treatment Nutrient/1,000 kcal ME
Vitamin E	200-250 mg
Vitamin C	37.5 mg
Selenium	0.125-0.325 mg
L-carnitine	62-185 mg
α-lipoic acid	32 mg
Caprylic acid	11.32 mg

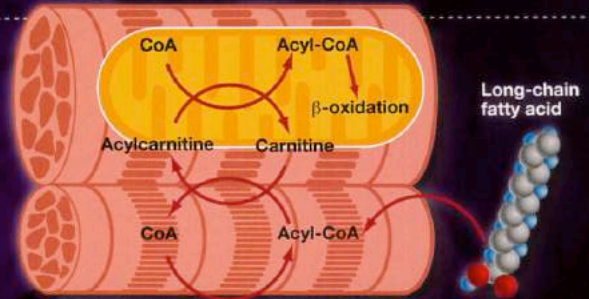
# fight CDS (II)

## Supplements for mitochondrial activity

### 2

#### L-carnitine

This substance transports long-chain fatty acids through the membrane of the mitochondria to be oxidized. Most of the L-carnitine is found in the skeletal and heart muscle tissue.



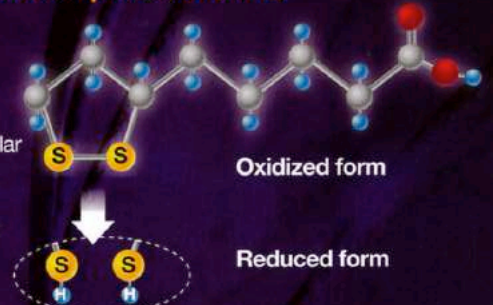
Its synthesis is endogenous in the liver, using the following as substrates: lysine, methionine, ascorbic acid, iron, vitamin B<sub>6</sub> and niacin. The supplements of this nutrient attempt to reduce ROS by increasing mitochondrial function efficiency. No specific dose for use has been described.

### 3

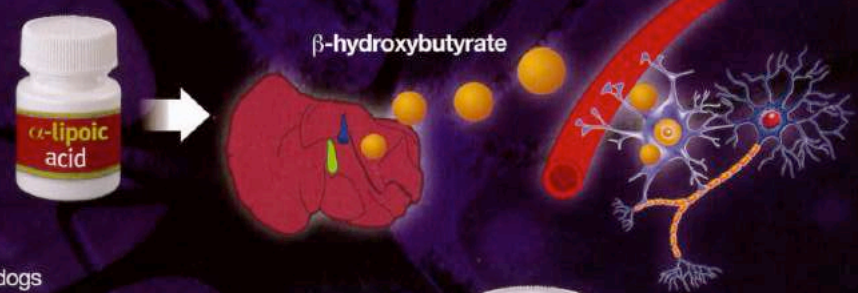
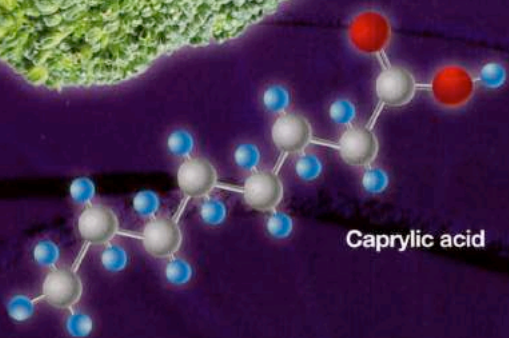
#### Medium-chain triglycerides and $\alpha$ -lipoic acid (AAL)

$\alpha$ -lipoic acid is derived from caprylic acid (octanoic acid). Its antioxidant effects are not clear. There are two theories:

- ✓ They are due to its reduced intracellular form (dihydrolipoic acid), which eliminates ROS.
- ✓ They modify the genetic signals that allow for an improvement of the antioxidant state of the cell.



Also, incorporating medium-chain FAs such as caprylic acid (11.32 mg/1,000 Kcal ME) in food rations for sick dogs represented benefits in the different evaluation tests. This FA is converted into ketones ( $\beta$ -hydroxybutyrate) in the liver, and these are the alternative substrate to glucose for the astrocytes. The habitual substrate for neurons is glucose, but with age, the capacity to metabolize it and obtain ATP is reduced. This explains the relationship between CDS and metabolic alterations.



#### Be careful with $\alpha$ -lipoic acid in cats

- ✓ It cannot be used at the same doses as those used with dogs or other species, such as humans or rats, as it would be toxic for cats.
- ✓ The maximum tolerable dose is 13 mg/kg of body weight (almost 10 times less than in dogs). At a dose of 30 mg/kg, non-specific semi-acute hepatitis can already be observed. The hepatic changes are evident due to an elevation of blood urea nitrogen (BUN) and a decrease in the ratio between branched and aromatic amino acids. It is not entirely clear if the cause of the toxicity is due to the accumulation of  $\alpha$ -lipoic acid favored by the entero-hepatic circulation or due to a defect in the enzymes responsible for detoxification.

