Zinc and Selenium

Their roles in maintaining health, and the effects of deficiency

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- **The role of Zinc :**

Zinc is one of the essential trace minerals required in a dog's diet to maintain good health. It is also one of the most abundant minerals found in the body, and is concentrated in certain parts of the brain, pancreas, and adrenal glands, as well as being present in the nucleus of all cells.

Zinc is involved in a vast array of metabolic processes in the body; It has been scientifically identified as playing in a key role in over 200 critical enzymatic / metabolic pathways, is integral to the function of the whole immune system, is involved in the production of numerous hormones (thyroid hormone, insulin, sex hormones, growth hormone, cortisone ...), and plays an integral role in DNA synthesis, and therefore cellular reproduction. Zinc also plays a major role in brain function, learning and memory, as well as maintaining good eyesight. In the skin, zinc plays a role in maintaining healthy skin and is involved in hair growth and regulation. It is also vital to normal skeletal development and collagen synthesis. Zinc is also one of the more powerful anti-oxidants in the body.

Of the many and varied functions zinc performs in the body, perhaps its most vital role is that of DNA and RNA replication. DNA is required not only for cell division and growth, but also for the expression of genetic material (the translation of genetic codes (genes) into their metabolic function). At this level, zinc influences the molecular genetics of an organism, and deficiency of zinc can have far reaching effects, that can even be passed on to future generations.

- **Causes of Zinc deficiency :**

The most potent sources of dietary zinc are found in red meats, white meats, and fish (especially oysters). It is also found in reasonable levels in cereals, legumes and root vegetables. Dietary deficiency can be caused by diets that are low in meats (ie vegetarian diets for dogs), but also in diets where the meat content has been highly processed and nutritionally damaged. Other more common and poorly understood causes of deficiency are now being discovered. Diets that are high in refined cereal grains are also high in plant phytates (especially soy based products), and these phytates actually bind to zinc in the intestines, and render it unabsorbable. Many cheaply prepared commercial dog foods have high cereal content, and often

have high levels of soybean protein. Over supplementation with calcium also reduces zinc absorption, as does high intakes of iron supplements.

Any disturbance in gastrointestinal function will also affect zinc uptake. Chronic diarrhoea, inflammatory bowel disease, pancreatic insufficiency, and malabsorption syndromes can all cause zinc deficiency. Also the long term use of certain heart medications (diuretics and ACE inhibitors) can lead to excessive zinc losses.

- **Effects of Zinc deficiency :**

Given the vast array of metabolic processes that involve zinc, it is not hard to understand why zinc deficiency has wide-ranging and seriously detrimental effects on general health.

The first, and most easily missed, sign of zinc deficiency is reduced appetite and gradual weight loss. Prolonged deficiency then starts to show more serious signs.

In the skin, deficiency causes a disruption to normal cell division, and the skin becomes dry and flaky. As it progresses, the skin can become grossly thickened and scaly looking (hyperkeratosis), similar to human psoriasis. Hair growth is also retarded, and eventually hair-loss spreads over the body (alopecia). In conjunction with the skin changes, the entire animal's immune system is severely depressed, and secondary bacterial skin infections and pustular dermatoses occur, along with increased susceptibility to all manner of bacterial and viral infections. Poor wound healing is also a notable sign, as is damaged and brittle nails, and thickened and crusty nasal pads and digital pads.

Deficiency of zinc during pregnancy and foetal development can lead to severe growth retardation, limb abnormalities, swollen joints, and poor skeletal formation. Brain development is retarded, and learning and cognitive functions are inhibited. Long term deficiency can result in premature ageing, senility, vision loss (especially night blindness), and hearing loss.

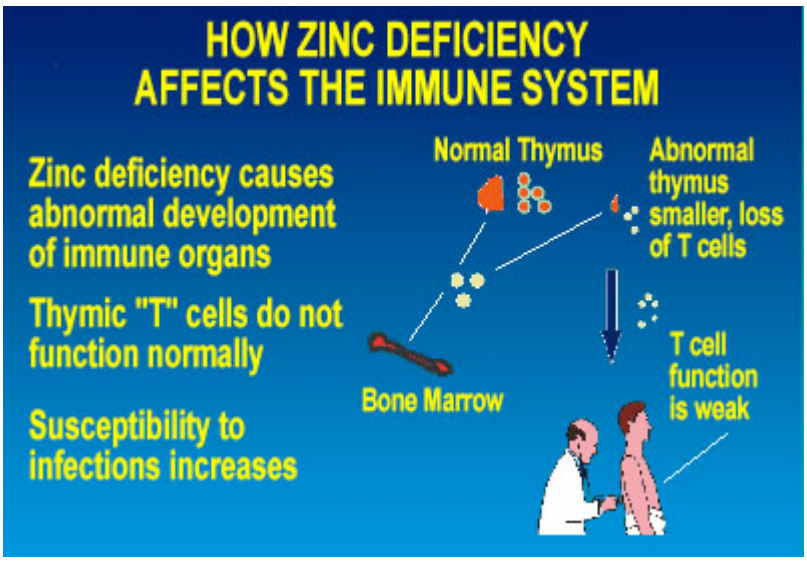
Reproductive performance is seriously affected by zinc deficiency. Because zinc is required for the production of the sex hormones (testosterone, oestrogen etc), deficiency of zinc causes abnormally low levels of these hormones. In male dogs it can cause low sperm count, loss of libido, and testicular atrophy (shrinking testicles). In bitches it reduces ovarian function, causing poor ovulation and low egg numbers, resulting in poor conception rates, small litter sizes and weak, under developed puppies of low birth weight.

Zinc deficiency also affects many other hormones, and can be involved in hypothyroidism, diabetes, and dwarfism. Its effect on suppressing the immune system has also been documented to prove that it makes animals more susceptible to developing a large range of degenerative diseases, including cancer.

During early post natal development, the puppy's immature immune system begins forming from bone marrow tissue. These immature immune cells leave the bone marrow and migrate to the Thymus gland, where they are "educated" to become mature immune cells (called thymic cells or "T" cells). These T cells are responsible for a significant part of the immune system, and

are able to differentiate between normal body cells and “foreign” cells (ie bacteria, viruses, fungi, and cancer cells). The T cells are critical to normal immune function (these are the cells destroyed by the HIV virus leading to immune failure). Zinc is essential for the growth and development of the thymus gland, and for the proliferation and “education” of T cells.

When zinc is deficient, the thymus is small, or non existent, T cell numbers are low, and their normal function is severely compromised, leading to a significant increase in infectious diseases, auto-immune disease, degenerative conditions, and ultimately cancer.



- **Supplementation :**

Diets high in fresh meats should not require additional zinc supplements. Most premium commercial pet foods have additional zinc added to the ration, to counteract any damage/loss during processing. The ideal minimum level of zinc in the diet is 120 ppm (parts per million – AAFCO standard). For home prepared diets, additional zinc, in the form of zinc sulphate or zinc oxide, can safely be added at a rate of 10mg per 25kg bodyweight daily.

- **The role of Selenium :**

Selenium is another essential trace element required in a dog’s diet, but at a much lower level than that of zinc. In fact, high doses of selenium can be quite toxic, and a majority of scientific research into selenium was originally focused on its toxicity, not on its benefits. It was only recently discovered that selenium deficiency can have a significant impact on overall health.

Selenium’s major function in the body is its involvement in the production of anti-oxidants, in particular, the anti-oxidant enzyme Glutathione Peroxidase. Anti-oxidants play a vital role in the bodies defence mechanisms. During normal cellular function (the creation of energy in the cells), oxidation reactions occur that produce by-products called “free radicals” – these free

radicals are extremely reactive, electrochemically unbalanced molecules, with a negative charge (most commonly negatively charged oxygen), and although they are very short lived in the body (fractions of a second), they can cause electron transfers which result in massive energy releases within the cells, resulting in untold damage to the biological systems, including damage to DNA, proteins, fats, and the intracellular components.

Luckily, the body is well equipped with a cascade of anti-oxidants, which function purely to remove these free radicals as soon as they are produced, and before they can cause damage.

Anti-oxidants are generally enzymes that require certain levels of trace elements and vitamins for their production. The two most powerful anti-oxidant enzymes (glutathione peroxidase and superoxide dismutase) both require adequate sources of selenium to function. Other nutritional elements that combine to produce anti-oxidants include vitamins E (alpha-tocopherol), vitamin C (ascorbic acid), vitamin A (beta carotene), and the trace minerals zinc, copper and manganese. Numerous other anti-oxidant compounds can be found in most fresh foods and many herbs.

Health problems arise when either the production of free radicals is increased (consuming all the body's anti-oxidants), or the level of natural anti-oxidants in the body is decreased or depleted. Depletion of anti-oxidants is generally caused by a combination of deficient nutritional intake of the above mentioned vitamins and minerals (poor diet, highly processed foods), combined with an increased consumption of anti-oxidant enzymes (ie increased production of free radicals).

Free radical production can be increased by a number of factors. Most significant in Western society is environmental pollution. The chemicals known to produce free-radicals include chlorinated hydrocarbons, aromatic hydrocarbons, industrial acids, solvents, most pesticides and herbicides, preservatives in foods, printing pigments and inks and other industrial chemicals, fragrances and perfume vehicles, cosmetic vehicles and cosmetics, pollutants in air and water, many if not all pharmacological agents used in medicine and anaesthetics, which have a profound affect in producing radicals in the central nervous system. Chemical mobilisation of fat stores under various conditions such as lactation, exercise, fever, infection and even fasting, can result in increased radical activity and damage in particular to the immune and nervous systems. Stress (both physical and emotional), increases production of the hormones adrenaline and cortisone, which are then metabolised and result in high levels of free radical production.

Free radical damage has now been clearly identified as having a central role in most, if not all, degenerative diseases, and can ultimately be linked to chronic immune failure and the formation of cancerous cells in the body. The simple process of ageing, is understood to be directly related to the gradual decrease in anti-oxidants in the body, and the subsequent rise in free radical damage.

- **Causes of Selenium deficiency :**

Selenium deficiency is primarily caused by inadequate dietary intake. Many countries around the world have soils that are deficient in selenium, and as a result, the plants (crops, cereals, pastures), and subsequently animals,

that exist upon the local food chain, also become deficient. Major agricultural countries like the USA, China, Australia, and worst of all, New Zealand, have soils that are naturally selenium deficient. These countries also export a large volume of produce world wide, and as such, many other countries, that have adequate selenium soils, can still have a population that suffers from selenium deficiency.

- **Effects of Selenium deficiency :**

The effects of selenium deficiency can mostly be explained by its resultant effect on decreasing supply of the critical biological anti-oxidant Glutathione Peroxidase. An increase in free radical formation and damage can result in far reaching damage to all cells of the body.

Selenium deficiency has been proven to be linked to weakened immune system, cause infertility, allergies, asthma, cataracts, hypothyroidism, and directly increases the incidence rate of cancer and cancer spread within the body.

With regard to the immune system, selenium deficiency retards the function of neutrophils (white blood cells), which are the body's first line of defence against bacterial infection. In the reproductive system, it can cause lowered sperm count and shrunken testicles in males, and early embryonic death, poor birth weight, and increased neonatal mortality in bitches and puppies.

With regard to thyroid hormone, selenium is required to transform the less active T4 hormone, into the biologically active T3 hormone, and as such, can result in hypothyroidism, even when some results (eg.T4) appear normal.

In the skin, dogs will show worsening in allergic conditions, and an increase in non-responsive dermatitis, due to the lack of anti-oxidant enzymes in the body. Accelerated ageing is also a natural consequence of selenium deficiency, and the associated increase in degenerative diseases and immune failure.

- **Selenium supplementation :**

Selenium is naturally high in nuts, legumes, cereals, and yeast products, and is also rich in fish and liver. It is also present in dairy products, kelp, wheat-germ, and molasses. Yeast is one of the safest and cheapest sources of selenium (also has B vitamins, and chromium).

Supplemental selenium is usually in the form of sodium selenite or sodium selenate, and can safely be added to a diet at the level of 0.1 – 0.3 ppm. As a daily dose, a 25 kg dog can take 50-100 mcg (micrograms) daily. The AAFCO minimum requirement for selenium is 0.1 mg/kg, and maximum is 2mg/kg.